The Impact of Artificial Intelligence (AI) Systems on Future University Paradigms

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Abstract

This paper explores the potential of artificial intelligent (AI) systems in the university's core functions of teaching, learning and knowledge nexus, against the background of rapid technological change, globalisation and challenges facing universities to respond to societies' needs in the knowledge age. As knowledge and innovation will drive competitive economic advantage in increasingly Internet defined infrastructures, a new university paradigm is needed where telecommunications and computers replace roads, buildings and transport technology that underpinned the industrial university that operated in the industrial age. As the Internet a global communication tool continues to impact on all human activities and enterprise changing the way we shop, bank, do business, entertain ourselves, communicate and think, it is radically changing how, when and what we learn. This paper introduces the idea of a HyperClass based on HyperReality, an advanced form of distributed virtual reality where physical reality and virtual reality, and human intelligence and artificial intelligence intermesh and interact to provide anyone, anywhere, anytime learning, in which teaching could be done by Just in Time Artificially Intelligent Tutors (JITAITs) that will pop up when needed, whilst students use avatars –online simulacra of themselves – to interact as telepresences in classes from different countries and locations.

Keywords: Modern university paradigm, Virtual University, Internet, globalization, avatars, HyperClass, just in time artificially intelligent tutor (JITAIT)

Introduction

Since the 1990s, universities have been experimenting with distance learning and its successors, e-learning, virtual classes online, flexible, and blended learning to respond to the increasing worldwide demand for higher education. Education is considered a key strategic tool for new approaches that enhance the value of knowledge and innovation that will drive knowledge economies.

Who should teach what to whom, on what media, and with what effect will be the main challenge for universities in the future. We are all products of the modern university born in the industrial society when railway and road networks provided the infrastructure for the movement of people, goods and services. As the infrastructure for the for the knowledge society is the Internet and the World Wide Web (WWW) it is argued that we need an education system that is based on telecommunications (Tiffin and Rajasingham, 1995).

The radical difference between a virtual university and all previous universities is that students, teachers, knowledge and problems come together as bits of information, rather than only as atomic substance. In the neo-Vygotskyian approach (Vygotsky, 1978) education takes place when teacher helps learner to apply knowledge to problems. In the future this process will take place on the Internet space without rectangular walls and without rectangular desks, where learners and teachers communicate through satellite and cable, browse on the World Wide Web and interact in fully immersive virtual classes as telepresences that replicate the conventional classroom communications functions using sight, sound, smell and touch.

The first generation of virtual universities in the 1990s, as open universities used the Internet instead of the postal service for the interaction between teachers, students and content. The dynamic of

synchronous, fully immersive and mediated face-to-face communication that has been possible in the conventional class, which explains its survival for some 4000 years is beginning to emerge in the virtual class and the Internet and the WWW will supplement, but not replace the conventional teaching/learning/knowledge nexus.

However, the game is changing as the new economic realities and expanding Internet capabilities define human environments. The World Trade Organisation's General Agreement on Trade in Services (GATS) sees university education as an information service that can be traded globally. Education is becoming competitive, and big business. However, trade blocks, free trade zones, deregulation, privatisation, new markets, and new players such as India and China, competition and technological interconnectedness that characterise this decade will need to be addressed.

The Impact of the Internet on Universities

Conventional universities bring students, teachers, library and researchers together using building and transport technologies based on depleting and increasingly costly fossil fuels and environmental pollution. Virtual universities bring them together by means of the Internet a ubiquitous network that enable globalisation. As the Internet, bandwidth and computer processing capability grow, speech recognition, multilingual systems, wearable computing, wireless Internet, artificial intelligence, avatars, virtual reality and HyperReality are becoming available, revolutionising how we live, shop, bank, think, communicate and learn.

Universities in the future may operate very differently because of complex information technology, but what they teach and research and how they teach is still embodied in language and validates the corpus of knowledge that constitutes the prevailing paradigm, just as it has been for over two and a half thousand years. And even if it is possible to deliver an encyclopaedia in a second, there is unlikely to be a matching increase in our reading speed.

Past Perspectives

John Fisher, Chancellor of Cambridge University (1514-35) who lost his head defending papal infallibility is also celebrated as the person who almost single-handed brought renaissance learning to Cambridge (de Hamel, 2001, p. 29). A hundred years ago university education was only available to privileged elite. Worldwide, the doors are being opened to increasing numbers of people seeking higher educational opportunity, while at the same time as government subsidies for universities decrease in the developed and developing societies.

What is the purpose of a university? Georgette Wang who writes about the information society (1994) suggests that the purpose of a university is to address the great issues of our time. So, what are the great issues of our time? It is suggested that one of the major challenges of our time is global interconnectedness and the need to develop a university that rises above partisanship to cultivate cadres of professionals who deal with global issues such as environmental degradation, terrorism, ideological clashes, credit crunches and pandemics in consonance with national and local imperatives, 'thinking global and acting local'.

The late 1980s saw the explosive growth of the World Wide Web (WWW). According to Howard Strauss (1999) in 1981 about 200 computers hosted Web servers, and in July 1998 there were over 36 million web servers (Strauss, 1999). According to Netcraft's Web Server Survey (2003) the number of hosts found running Internet web sites is over 40 million in April 2003 but not exhaustive.

Today's virtual universities on the Internet function asynchronously. These are growing exponentially on the Internet, marketing themselves as a no-frills pathway for autonomous learners to get a degree by cutting out the trappings and non-essentials of university life. In so doing, they are acquiring a reputation as degree mills and questions their validity and creditability.

In synchronous mode, speech, the first tool of human communications allows rapid intuitive interaction, and the subtle sensory cues of gesture, expression, position and voice which are critical for learning. Today we have the clumsy click-to-talk audiographic and videoconferencing systems available on the Internet with their delays in response and their unreliability and audio quality today remains a problem.

Although a democratic tool for information access and conversation, the Internet and the WWW are not designed as a university library. The Internet has become a virtual audiovisual cacophony of massive corporate sites and flickering advertising displays, a vast dubious megamall that offers space for investment frauds, purveyors of pornography, where antisocial behaviours lurk and hackers proliferate free range viruses. People now seek information on the Internet at their peril, not knowing what comes with it nor which database operators are buying access to their personal information-seeking habits. Universities set up watchdog mechanisms to restrict and monitor the use of the Internet sites as its future as an academic medium falls into question not because of its capability but because of its associations and reputation. The Wikipedia, wikis, blogs, Facebook, Bebo, mobile technology and SecondLife add further need for filtering, verifying and authentication of content, posing a major challenge for teachers as they move towards learner-centred learning.

But the technical limitations of today's Internet will be resolved as Moore's Law continues to apply and computer-processing power and software continue to double much faster than Moore's estimate of 18 months. As broadband is becoming available especially in the urban centres of the developed economies, wired and wireless telecommunications become more and more ubiquitous, and as part of our clothing accessories offer Internet access wherever we go.

Jonietz (2007) notes that the Nokia project builds on more than a decade of academic research into mobile augmented reality and interconnectivity where the small computers are now cell phones.

Avatars

A new technological paradigm needs to be developed for interfacing with information technology that will be direct, intuitive and multisensory to replicate how people interface with other people in the real world. A key component of such a paradigm could be an avatar when one day, wearable computers linked to transceivers develop to the point where they are part of the weft of the clothes we wear in a virtual reality could look and act and even feel like a replica of our physical personas. Cybersuits will become intelligent and autonomous, able to mould themselves to the shape of our bodies so that they can remedy physical problems we may have in mobility, eyesight and hearing. They will assist, protect and empower our movements (Drexler, 1990) while shaping our virtual presence to the way we want to look and sound to others. Today we are at an early stage in this development where there are many limitations, not least of which is the relationship between humans, and autonomous intelligent artificial lifeforms (ALife) connected through the Internet.

Katsunori Shimohara (2001) sees the initial relationship between humans and ALife as being similar to the relationship of humans to pets. He suggests that ALife taking the form as virtual characters that evolve in cyberspace will also take robotic form in physical reality. They would be creatures of HyperReality, living entities that are virtual and real, that can coexist with us in our avatars, and allow us to coexist with them as robots.

Research in the area of robotics is rapidly growing and today we see robotics applied to manufacturing, medical procedures, human mobility equipment, and care for elderly. Johns Hopkins University researchers are designing new robotic medical tools, a steady hand system for the operating room of the future in an effort to help doctors treat patients more safely and effectively, and allow them to perform surgical tasks that are nearly impossible today (Headlines@Hopkins News Release, 2006).

This article argues that artificially intelligent systems and sophisticated clusters of technology coming onstream will have significant potential to improve the core functions of a university-the creation, processing, dissemination and application of knowledge to real life problems- in culturally diverse global knowledge economies.

Artificial Intelligence (AI) Systems

The common definition of Artificial Intelligence (AI) as a branch of computer science that seeks to create a device to perform functions that are normally associated with human intelligence, such as reasoning and optimisation through experience and factual and heuristic knowledge. AI activity includes expert systems, natural language understanding, speech recognition, vision, and robotics.

Artificial Intelligence (AI) has been with us for half a century, and is already in common usage, and integral to the ICT infrastructures, for example in fridges, heating and refrigeration appliances, Internet search engines, banking software for processing transactions, medical diagnostic software, and provides the engine that drives robotics.

According to Nick Bostrom (2006) we have seen incremental progress in AI but not yet the great breakthroughs that people were predicting 30 or 40 years ago. He suggests that lot of cutting edge AI has filtered into general applications, often without being called AI because once something becomes useful enough and common enough it's not labelled AI anymore, and in his interview with CNN Bostrom believes that no machine has yet come close to passing the "Turing Test" -- the conversational test devised by mathematician Alan Turing in 1950 to determine whether a machine could "think" (CNN.com 2006).

In examining the potential of AI in education perhaps Bostrom's suggestion that traditional "top-down" approaches to AI, in which programmers coded machined to cope with specific situations, were being supplemented by "bottom-up" systems inspired by enhanced understanding of the neural networks of the brain, leading to more subtle forms of AI as expert systems could be relevant

Kenneth Rogoff (2006) suggests that the next few decades will see an exponential rise in the application of artificial intelligence in human endeavours. Rogoff cites the example of the game of chess, and notes that for most of the 20 century, programmers were unsuccessful in designing chess computers that could compete with the human chess master's ability to intuit, visualise and prioritise. Things changed in 1997 when IBM's Deep Blue computer stunned the world by defeating the world champion, Garry Kasparov. Rogoff suggests that later this century, one will be able to buy a pocket professor, perhaps with holographic images, as easily as one can buy a pocket Kasporov chess computer today.

Through the combination of ingenious software and massive parallel computing, programmers had produced a silicon-based entity that fulfilled the prophesy of the godfather of AI, Alan Turing who argued more than 50 years ago that the brain's function could all be reduced to mathematics and that some day, a computer would rival human intelligence (Rogoff, 2006). The Turing Test claims that the ultimate proof of artificial intelligence would be met if a human interrogator was unable to figure out that they were conversing with a computer.

Kavi Murthy (2002) sees an important role of AI in e-learning. He quotes Brandon Hall that the global corporate and government e-learning market will exceed $18 billion in the USA alone, and only innovative e-learning companies will spearhead that growth. Murthy argues that the move from first generation of e-learning systems to the second generation of e-learning systems will be based on the integration of e-learning and AI. This will involve borrowing characteristics from human intelligence and applying them as algorithms in a computer-friendly way to suit individual learner styles. The intelligent tutoring systems will behave like a real human teacher, and deploy a teaching approach that will best fit the learner's profile, personality and environment, providing real-time feedback (Murthy, 2005).

Tajuddeen Atolagbe (2002) adds to the literature on the use of AI in education in his interesting paper that effectively describes components technologies and AI methods (pedagogical agents) for efficient and effective management of instruction in distributed, collaborative environments.

Angeles Manjarrés (2007) reports on the research results of AI in global and integral e-learning in AI Studies and reflects on the potential of AI in education in a specific subject domain and is a useful lead in to the following section.

HyperReality

One of the technological platforms that could help revolutionise teaching and learning in universities of the future is HyperReality. Nobiyoshi Terashima (2001) conceptualised HyperReality (HR) a technological platform to intermix virtual reality (VR) with physical reality (PR) and artificial intelligence (AI) with human intelligence (HI) in a way that appears seamless and allows interaction. HyperReality, or something similar which are becoming available such as Croquet, ActiveWorlds, Secondlife and Gaming platforms based on AI that allow fully immersive multimediated environments could become an infrastructure technology for learning wherever there are broadband networks with Web 2.0 or 3.0.

In their interesting and intuitive article in Scientific American 1990, Paul and Patricia Churchland argue that the vague phrase coined in the 1950s 'could a machine think' should be replaced by the more relevant question 'Could a machine that manipulated physical symbols according to structure-sensitive rules think'? They conclude that classical AI is unlikely to yield conscious machines, but systems that mimic the brain might (Churchland, 1990).

The HyperClass in Virtual Universities

HyperClasses are based on HyperRality and can exist in real and virtual dimensions at the same time. In so doing they will provide an intersection between the local and global dimensions in education. Universities can be in different countries, and can link classes in different universities in other locations. A student could go to a conventional class in a conventional university or stay at home and use a PC and the Internet to link to a virtual class in a virtual university. A HyperClass allows a student to do both. A HyperClass exists where the virtual and real dimensions intersect in a coaction field where students and teachers in a conventional classroom can synchronously interact with students and teachers in other universities that may be in other countries to study a specific subject in a coaction field.

A coaction field conceptualised by Terashima (2001, pp. 9-12) is where students and teachers in a conventional classroom can synchronously interact for the purpose of learning with students and teachers in other universities anywhere. The HyperClass is where real and virtual dimensions of students and teachers intersect providing a common field to reconcile the learning that is local with learning that is global in order to understand the subject from multiple perspectives of other cultures than one's own (Tiffin and Rajasingham 2001, p. 110-125).

Participants in a HyperClass come together because of their interests in a specific subject domain, and it is suggested therefore, that the development of virtual universities can be dedicated to specific disciplines, in contrast to national universities that emphasise location, such as the Universities of Cambridge, Chicago, Heidelberg or Hong Kong. Instead, the emergence of virtual universities in specific fields such as communications, nanotechnology and Chinese literature and so on could emerge, fitting with Terashima's (2001, p.8) definition of HyperWorlds as a technical environment where coaction between reality and virtual reality is based on a shared domain of knowledge, such as mathematics, medicine or nanotechnology. However, subjects such as law, religion or history are nation based and not subject to universal scientific laws such as physics, and therefore are best studied within national education systems.

A HyperClass is a form of teleconferencing where the avatars, the setting and the objects of study are three dimensional and virtual objects can be handled, modified and passed between virtual and real people. A further strength in a HyperClass is that participants in their own physical environment can collaborate with other participants also in their own environments who appear as virtual, and together modify the subject of study. This adds richness as people are working with objects and environments that they have designed instead of, as in virtual reality, having to work with environments created by computer software and graphic designers. In 2000 the world's first HyperClass was successfully conducted when a virtual disk was handed from a participant in Japan to a participant in New Zealand showing how to fit it into a 'virtual' computer. The New Zealand participant in turn passed the disk to a participant in Australia and demonstrated the same skill. Then the disk was passed back to Japan to successfully complete the World's first HyperClass between three countries. Although appearing simple, this experiment was the result of six years of collaborative research between the three countries, and enabled by teraflop computing power and broadband capacities.

In March 2007, an audience at Bradley University in Illinois was treated to a play performed by two virtual actors, whose images were projected onto the stage from their physical locations in Florida and Canada universities via Internet 2, and one live actor. The project was the first successful adaptation of an emerging art form and culture of multimedia that enables seamless presentations according to the researchers. Two computers at Bradley University handled up to 130 Mbps of data from both the University of Central Florida and the University of Waterloo as it received the virtual actors' images and projected them alongside the actual actor in real time on a stage comprised of 2D and 3D sets on multiple screens. At some points in the show the audience was unable to tell real from virtual. Logistics and technical considerations for further performances are currently being worked out where actors from

Florida, Canada and Illinois can interact without them ever leaving their respective campuses (Kotala, 2007).

According to Tiffin and Rajasingham (2001) there are no technological limitations to the number of centres and countries that can be linked together in a HyperClass in the future. Strauss (1999) prophetically notes that while today almost all web users are people, tomorrow, intelligent devices operating on behalf of people and institutions will dominate the Web. Looking at the impact of virtual reality, HyperReality, nanotechnology, and AI, Tiffin and Rajasingham (2003) suggest that with the decreasing costs, weight, size and the increasing speed of networks and computer power, the new teachers in a virtual university could be just in time artificially intelligent tutors (JITAITs).

JITAITs

What is a good teacher to one student is a monster to another and what constitutes good teaching in one episteme and one country may not be so in another. Although national education systems are reviewed regularly for quality control, there is little sign that teaching has improved over the ages, nor are we any closer to understanding what learning is. The new breed of university administration with its roots in business culture has little sympathy for what smacks of mystique and creativity and is prepared to standardise those teaching processes that can be observed and understood by the student customer. In so doing they create an environment for neo-Taylorism in universities. This raises the spectre of instruction being broken down into small clearly definable tasks that can be conducted by computers, and of the craft knowledge that a teacher has becoming the property of the university that employs them. This in turn raises concerns about the replacement of humans by computers, as the process of standardising and automating teaching expands with the commercialisation of universities. However, it is as naïve to think of universities in a couple of decades still being totally taught by humans as it is to think of them being totally taught by computers.

Vygotsky (1978) suggests that the teacher is available when the learner needs them to respond to queries as they arise. In the modern university with large classes with hundreds of students, this is not possible. Tiffin and Rajasingham (2003) conceptualised the idea of just in time artificially intelligent tutors (JITAITs) as their name implies is that they can be available whenever and wherever a student needs them and thus improve pedagogy. JITAITs are based on the concept of expert systems and intelligent computer assisted instruction (ICAI). These are effective where the domain of knowledge they address is restricted, paradigmatic and orientated toward problem solving. A JITAIT could therefore, be an expert tutor on a subject that formed the domain knowledge of a coaction field in HyperReality, for example, the subject geometry in the domain of mathematics. It would always be ready and uncomplaining to help any learner in the coaction field and would improve as a tutor from each encounter with a learner, provided it received feedback from a human tutor. Such a JITAIT could take over many of the low level repetitive student-teacher interactions, and is feasible today.

JITAITs could also act as personal tutors to individual students. They could search for information, keep track of where a student was in their individual programme of study and organise their learning activities. Interlinking intelligent agents that manage schedules, meetings, email and workflow are already used in office systems, and the Web-based organisation of programmes of study that is taking place in universities around the world provides a framework for such a development. In time we could imagine JITAITs acquiring form and personality to act as a guide and mentor in a student's learning life in the manner of the servant-tutor of the medieval university, and madrasas in Asia.

Something similar could be developed to have a similar support function for university teachers, managing their email, class schedules, student assignments, marks and grades and linking with student and university administrations. Essentially this is the addition of intelligence as office-based administration becomes automated and universities benefit from the applications of information technology that are taking place in the business world. A more interesting development for teachers will be when they get artificially intelligent assistants with voice recognition that can be linked to the corpus of a teacher's email. Since one of the main communicants for an academic is the university itself that spends a lot of time devising 'official' paradigms of university communications (who is supposed to write what, to whom and when) and since everyone in a particular university could have the same model of artificially intelligent assistants they could endlessly write to each other in bureaucratic harmony about bureaucratic things, leaving teachers get on with teaching (Tiffin and Rajasingham, 2003).

Knowledge Embedded in HyperReality

When global corporates, organisations and institutions present themselves multilingually and in our five senses embedded in HyperReality on the Internet, knowledge and its application will be more universal than knowledge in alphanumeric language. The process whereby science has gathered encyclopaedic knowledge of the physical world in words is starting to be repeated in four dimensional virtual realities.

In the modern university, knowledge became discoverable, quantifiable and formulaic and knowledge is seen as something that can be purchased or captured. Today we talk of knowledge processing and introduce courses and presentations in knowledge management in preparation for a knowledge revolution leading to a knowledge society.

Marvin Minsky (1986) first proposed the idea of small programs called agents with a degree of autonomy, an appearance of intelligence and the ability to work collaboratively. What we have looked at so far are the kind of AI agents that can collaborate with people on specific tasks and have the appearance of intelligence and are becoming part of office environments. They will become part of university information technology environments, and could take avatar form and be personalised.

> Professors now spend much of their time doing the work of secretaries. It is a reverse form of Taylorism in which they do a job they are not competent at for a salary way above that of someone who could do the job more efficiently. Collegiality has already gone global and awaits a university with matching vision.

The Changing Nature of Reality: Enter ALife

If we are going to have intelligent albeit artificial creatures living with us and working with us in the future, then perhaps they should be studying, teaching and researching with us in our universities. We need to learn to live with ALife before it develops complexity so that we have a better chance of achieving symbiosis with it. We have managed this over time with other life forms such as cats and dogs and we do not want ALife creatures to go feral. Better to have them studying with us in our universities than studying by themselves in their own universities to our exclusion.

Today, technological infrastructures are being developed without consultation with the main stakeholders in the education equation, namely the teachers and learners. Information technology is imposed on many universities by administrators who buy software systems with a mission to make money, and require academics to adapt to it. The new clusters of information technology that is emerging can open the door to extraordinary advances in education, but equally it can become an instrument of standardisation and automation for replacing the rich variety of university life.

As we move into an episteme of user pays where the student as customer is king, students want service, like for example given by banks and shops. This does not mean that instruction is any better or worse. University instruction these last fifty years has been full of fads, but nothing has emerged that is manifestly better than anything we have seen over the last two and a half thousand years.

Now we seek to solve education's problems with the Internet. Do we really have the kind of breakthrough technology that surgery got with anaesthetics and doctors with antibiotics? Or its Pasteur, or Lister? Or will the HyperClass in virtual universities prove to be yet another educational fad?

What happens as the number of those who go to university passes parity with those who do not? Do we see the emergence of a knowledge digital divide? Will we see the emergence at one extreme of cognitive elites, and at the other feral outcasts languishing in prisons?

Conclusion

This conceptual paper poses questions for further research. Although many aspects of this paper may seem today like 'science fiction', browsing the Internet shows that the future is nearer than we think. This paper does not purport to give answers but suggests a possible philosophical foundation for a future virtual university paradigm. The core function of a university irrespective of the episteme is the creation, processing, dissemination and application of knowledge to world problems where teachers help learners to apply knowledge to problems. As education becomes competitive big business, it appears that when academics run universities they fail to operate them as businesses. When business people run

universities they fail to operate them as universities. In reality, we need to accommodate this duality. What is needed in a university of the future is a research paradigm that can project its thinking to address the problems of the future, seeing problems from the perspective of an Islamic country as well as that of a Christian country, from that of the rich who want economic globalisation as well as that of the poor who see it as cultural imperialism defined by the developed world. There is a need for a new sense of direction in university research that is independent of interests and dedicated to the issues of globalisation and equity. We need to do research in multilingual teams that can deal with problems from the multiple aspects of different cultures, to go beyond its basic appearance as a commercial phenomenon to include its ecological impact, effect on cultures and communications and the implications this has for the way we educate, trade and cope with pandemics.

There may come a day when conventional universities adopt the basic principle involved and become vending outlets for a variety of competing virtual universities, while the sporting, recreational and social functions of the traditional campus provided a common ground for students to date, dance and play no matter what university they had joined.

In his article entitled 'How necessary are universities?' Alan Peacock examines the problems of getting accredited and quotes Adam Smith: 'When a man has learned his lesson very well, it surely can be of little importance where or from whom he learned it' (Peacock, 2001, p.6).

Finally, to quote Lovelock that supports improving the university status quo:

> As a scientist, I have been an explorer looking for new worlds, not a harvester from safe and productive fields, and life at the frontier has shown me that there are no certainties and that dogma is usually wrong (Lovelock, 2000, p.5).

We must continue our research into the future of education that is relevant to the emerging new learner expectations in the knowledge society.

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