

A Novel Model for Academic, Transcultural, and Global ICT Education, employing the full potential of ICT

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Abstract. *This paper proposes an integral view on Information and Communication Technology (ICT) education in an academic setting, applicable to Africa. It infers a novel model for ICT education, based upon experience gained in the course 'The Evolution of the Internet' (EVOINT) in the Netherlands and Zambia.*

The proposed model emerges from a vision for a University of the Future, where students learn explicit knowledge online and meet with professors and peers to connect and integrate within the local societal and cultural context. The model integrates principles of blended learning, peer assessment, and students from all disciplines.

Experiences in the Netherlands and Zambia demonstrate the relevance of the holistic approach. Three years of experience with the course has demonstrated the importance of the holistic webscience approach to ICT education. It provides an indication of the vast potential of ICT and social media to empower the education process worldwide.

Keywords: ICT education, blended learning, University of the Future, trans-disciplines

THE NEED FOR ACADEMIC ICT EDUCATION IN AFRICA

Technology, in particular Information and Communication Technology (ICT) plays a pivotal role in the current, fast-changing world. Literature recognises the significant contribution of ICT to economic growth and innovation (Andrianaivo and Kpodar, 2011; United Nations ICT Task Force, 2005). For developing countries, ICT has significant potential for improving living conditions, contributing to economies, boosting education and health care and, most of all, empowering citizens, by providing them with access to information and facilities for communication and collaboration (World Bank, 2012).

Examples of the power of ICT for development can be seen in various places in Africa. One example is the village of Macha, in rural Zambia, which is a model of how internet facilitates the inspiration of people in rural communities to reach their collective and individual potential (Matthee, Mweemba, Pais,

"International Conference on ICT for Africa 2013, February 20 -23, Harare, Zimbabwe"

van Stam, and Rijken, 2007; Johnson, Belding, and van Stam, 2012). The Macha Works implementation model, which relies upon the facilitation of ICT, is a model for innovations in many other villages in Zambia (van Stam and van Oortmerssen, 2010; van Stam, 2011).

Several circumstances hamper the employment of ICT in Africa. These constraints consist of environmental, skills, and cultural constraints. The over-arching issue is the lack of infrastructure for accessibility. Over the past decade, the connections between Africa and the rest of the world have multiplied. Investments and arrival of sea cables coincide with master planning and development of terrestrial fibre networks (Isaacs and Hollow, 2012; Chege, 2011; Habeenzu, 2010). Until recently, connectivity in rural areas could only be achieved through satellite links, which is extremely expensive and, even at high cost, only provide very limited bandwidth. Fortunately, the fast proliferation of mobile phone networks has extended possibilities for Internet connectivity, although coverage, bandwidth and costs remain an issue.

Then there is the human capacity issue. Realising the development potential of ICT requires an abundance of people with drive, vision, leadership capabilities and technical knowledge of ICT, grounded in the local context and culture. At present, there is a lack of human capital in this field. To change this, the whole education system (primary, secondary, vocational as well as academic) must embrace education in ICT. Therefore, it is of utmost importance to start with adequate ICT education at the highest level (e.g. Master's programmes) in order to raise up young people that can:

1. help build up ICT education at all levels,
2. develop an indigenous scientific and applied research, and innovation systems,
3. provide for the need for immediate ICT knowledge in industry and government organisations,
4. start indigenous businesses in ICT and collaborate world wide.

THE DEVELOPMENT OF ICT AND ITS EFFECT ON EDUCATION

ICT is a disruptive technology. ICT provides the physical infrastructure, the data, and means of knowledge generation. It has a profound effect on the way we live and work, on behaviour and social life. It affects all aspects of society, including education. Although the world has evolved into a post-industrial society, the education systems are still focused on the needs of the industrial era. In fact, educational systems programme young people to be ready to perform jobs in industry. The systems train youth for jobs that no longer exist, while youth must be prepared for jobs that will emerge in 5 to 10 years time; jobs that cannot yet be imagined. This is congruent with the fact that, at this moment in time, new jobs carry titles like 'Big Data Analyst', jobs that were not imagined 10 years ago.

Thinking about education we have to consider the questions: *why*, *what* and *how*, in that order. The *why-question* is the most basic, albeit the most difficult question. Probably the answer should be: to prepare the next generation to be able to lead a purposeful and fulfilling life, in which they can develop themselves and contribute to the progress of humanity.

The answer to the *what-question* obviously changes over time. Worldwide, government and business recognise that the ongoing development of ICT and its importance for society requires its citizens to be educated in digital skills. Additionally, sufficiently trained ICT specialists are in demand to build and maintain the infrastructure as well as the applications. The ongoing swift, and even accelerating, development of ICT requires lifelong learning. The knowledge that young people learn in school and at the university expires in very few years. It is essential that young people learn so that they can take responsibility for their own continuous development after their formal education. Also, ICT intertwines with many other disciplines: there is a need to understand not just the technical working of computers and communication networks, but also their interaction with human society. Therefore, ICT

education and research must be increasingly trans-disciplinary in nature. Webscience, a term coined by the Web Science Research Initiative, aims at studying the development of ICT in such a trans-disciplinary way (Berners-Lee, Weitzner, Hall, O'Hara, Shadbolt, Hendler, 2006).

Besides the content of education, (*the What*), the form in which education takes place (*the How*), is affected significantly by ICT. This holds for courses in all disciplines, not just for ICT. Technology is truly disrupting the education system (Chen, 2010). eBooks, utilising applications on notebooks and tablets, replace printed textbooks. Digital blackboards enhance the classrooms. In addition, students can find information on the Internet (e.g. Google, Wikipedia) and use social media to communicate (e.g. Facebook, Mxit). Experiences such as 'the Hole in the Wall project' (Mitra, 2003) have revealed how access to Internet empowers children to learn. Then one should not under-estimate the contribution of computer games on learning and skill development.

Last, but not least, there is an explosive growth of online courses such as Kahn Academy, iTunes University, Udacity, Coursera, (and others) becoming available. As a result of these developments, the well established universities like Stanford, MIT, Harvard are in a confused state and wonder what their future will look like. What is the role of universities in the future?

A VISION FOR THE UNIVERSITY OF THE FUTURE

Science goes through identity crises and must re-invent itself constantly (Mitchell, 2006). Education needs a firm foundation in human values to cultivate a form of life with which students and teachers can identify (Mittelstrass, 2006). The University of the Future will have to address moral issues and the real need of the local and global society. Topics like research skills and entrepreneurship need to be intertwined with the academic.

In the future, students will not have to choose a specific university. Instead, they can select various courses by the best professors and put together their own programme. There will still be a need for some authority to check the achievements of the student and issue a certificate. But it is questionable whether online courses can replace the role of a university entirely. An important part of education consists of the interaction with professors and peers. Students have to learn to collaborate in teams and need their peers to engage in discussions on values and to develop a shared vision on future challenges for science and society.

The form of future academic education will most probably be a kind of blended learning: a combination of online lectures for transfer of explicit knowledge, combined with interactive class work where professor and students meet and discuss. Online interaction and group work using social media supplements real life interaction.

From this, a picture of the University of the Future emerges. Without doubt, it will be a networked university, embedded in the global academic community, with some strong regional as well as long-distance links, and a lot of weaker global links. The university will be a meeting place for students and scholars, where they interact in projects and discussions on science, research and innovation, on the challenges for the future, the role of science in the local society, as well as in the world at large. The students, scientists and professors will be part of a global network. Students will select their courses from the network rather than their particular university, while professors provide their courses to the network, and scientists participate in international projects. So, primarily, the university becomes a hub in a network, connecting people in different places. But at the same time it will be a physical focal point and meeting place, where debate takes place, where critical thinking is stimulated, where students and professors are challenged, where moral issues are taken seriously. It will be a place where connections are

fostered between disciplines to develop a holistic view and understanding of reality, within the local societal and cultural context.

CASE 'EVOINT', AN EXPERIENCE WITH WEB SCIENCE EDUCATION

In order to respond to the need for a course that gives a broad understanding of the development of the Web, in the spirit of *webscience*, the course *The Evolution of the Internet* (EVOINT) was developed as part of the Masters programme 'Human Aspects of Information Technology' at Tilburg University in The Netherlands. This course is constructed with the potential for worldwide use in mind. Particularly, it was envisioned for implementation in developing countries. EVOINT was tested as a 'presentation series' at the University of Zambia.

The ability to understand technology deeply and the ability to engage in technologies like ICT might define the difference between the citizen of the past and citizen of the future (Kam, 2012). Therefore, the course not only suits students specializing in ICT or computer science, but also any liberal art/humanities or engineering/science students. They should all be familiar with these developments and acquire the necessary skills for the digital era.

Content

The main objectives of the course are:

1. to give students insight into the structure and dynamics of the Internet, creating awareness of what is factually happening,
2. to develop critical thinking,
3. to learn to think conceptually and see the connections i.e. 'the big picture',
4. to make students aware of the speed of developments, as tomorrow everything will be different. ie to 'learn to learn' in order to adapt continually to change,
5. to learn to use the web to its full potential for learning and co-operating.

EVOINT covers many topics. These include:

- a) History of computers, computer networks, mobile networks, WWW, and social media.
- b) New developments such as open data, semantic web, the Internet-of-Things, and sensor networks.
- c) Structure of the Internet, WWW and social networks, and small world network properties.
- d) Basic concept of the Internet, OSI layers, and standards.
- e) Societal impact, changing behaviour and ethical aspects.
- f) Applications in business, healthcare, education, and entertainment.
- g) Underlying trends in the development: exponential growth (Moore's law), increasing connectivity of devices, people, data, converging media and increasing complexity.
- h) Exploring the future, possible scenarios, and the concept of singularity.
- i) Guest lectures on Multi Media, Security, Values in IT, digital storytelling, use of ICT and social media in organisations.

Course Format

Preparing students for the digital age necessitates using the possibilities of the digital age in the education process. This course is focusing on the recent and future developments of the Internet. Consequently the Web is the designated source of information. In addition, social media facilitates communications and provides for sharing and discussing of information.

In 2010, Google Wave provided the main platform for communicating and sharing information (Figure 1), in addition to Google Docs and Twitter.

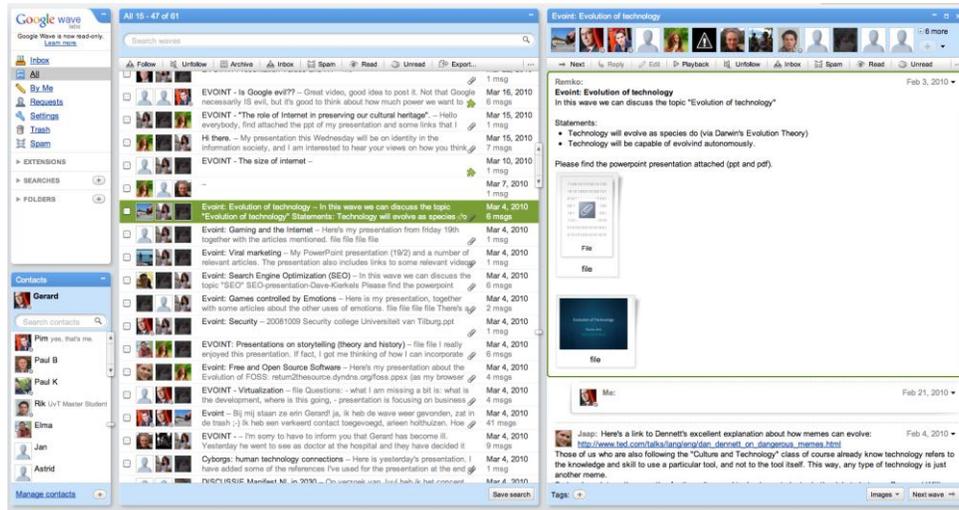


Figure 1: Screen-shot of Google Wave for EvoInt.

Google Wave appeared an excellent tool for the purpose of the course. Unfortunately, that service was discontinued by Google. In the 2012 course, the course experimented with a Facebook group (see Figure 2). Most students are familiar with this medium, and the experiences are favourable: all students, lecturers and a few interested outsiders join the Facebook group. An experiment with more groups for specific topics was not successful as not all students connected to the group in time. Google Docs serves as a repository for all documents, presentations of lectures, and student presentations.



Figure 2: Use of Facebook Group for EvoInt 2012.

Twitter is the medium for sharing links and short comments. A screen-shot of Twitter for the hashtag #evoInt is shown in Figure 3.



Figure 3: Screen-shot of the Twitter #evoInt timeline.

In addition to using social media, the course adheres to the principles of blended learning or the *flipped classroom*. This means methodology minimises one-way lecturing in a classroom. It utilises the time in a classroom as much as possible for interactions. Information transfer primarily takes place online.

The course consists of 14 lectures of 2 hours. Lectures take up half of these periods. The other half contains presentations by student groups and discussions. At the end of the course, the students have to write an essay. Students receive grades for their final essay, for the group presentation and for their

participation online as well as in classroom discussions. Grading of group presentations involves peer assessment. It is anticipated that the role of peer grading will be extended in the future.

Experiences EVOINT in the Netherlands

The course 'The Evolution of the Internet' started in 2010 and was run for the third time early in 2012. The course is one of the courses of choice for the Masters Programmes *Human Aspects of Information Technology* and *Business Communication and Digital Media*. Table 1 shows the number of students who followed the past three sessions of the course in Tilburg, The Netherlands.

Table 1. Students in EVOINT Masters, Tilburg University

Year	Number of Students in EVOINT Master course at Tilburg University
2012	36
2011	22
2010	15

The number of students grew by 'word of mouth'. Students like both the content and the innovative way in which the education process takes place. They shared their experience with friends. A number of students outside the Masters programme, and students from other Universities, follow lectures and/or participate in the online interaction on Facebook and Twitter. Even after completion of the course, online interaction continues. Some students stay in touch with each other and the lecturer. A recent quote from a student states: 'I continuously engage in online and offline discussion due to the set-up of the course. A lot of classmates post really interesting material and discuss it afterwards'.

The background of students is diverse. Some have a Bachelor in ICT or computer science, others in humanities, business administration, or marketing. The diversity in students' backgrounds does not present a problem in practice, since the focus is on the conceptual level with emphasis on the inter-relations between the various disciplines. Students can learn from each other when working in mixed groups.

Although students are familiar with web use and social media, the confrontation between the general trends of development and the interconnections between technology and social, legal and ethical aspects are an eye-opener for them. They become quite engaged, participating actively both in the classroom and in the online discussions. Students post material related to presentations in class online. Through peer-sensitisation, they discover new connections between topics themselves. Trending topics in the news often connects to subjects in class and provides ample opportunity for discussions. Examples are Wikileaks and the role of social media in the revolutions in Arab countries during the 2011 course. Likewise, SOPA, PIPA and ACTA legislation in connection with copyrights and downloading featured during the 2012 course.

Student group presentations usually start a few days before the presentation day, with posts on Facebook of background material, provocative statements for discussions, and sometimes polls. During class, most of the time is spent on discussions. After class, students continue discussions during lunchtime and online discussions carry on 24/7. The groups choose different topics, but the discussions often lead to the underlying phenomena and trends, such as the need for new (international) legislation for copyright and privacy, the importance of ethical aspects and values, the need for new business models, the increasing transparency of the world, the need for critical thinking and managing our attention.

A challenge that requires more research is how to measure students' progress in an objective way. Progress is measured against the main objectives of the course:

1. learn to think critically when it comes to information and phenomena on the web,
2. think conceptually,
3. see the interconnections between different phenomena and be aware of the flux, and
4. *learn to learn* in order to be able to adapt to the continuous change.

Experiences EVOINT in Zambia

During 2011, a presentation series on *the Evolution of the Internet* took place at the University of Zambia, facilitated by the School of Engineering, at undergraduate level. UNZA students organised the set-up of the course. A lecturer from rural Macha, Zambia, facilitated content transfer.

Attending students mostly came from final year students of different schools at the University of Zambia. The curriculum was transposed from the EVOINT classes in the Netherlands. Presentations utilised online tools like Google Sites and Groups. The innovative approach encouraged guest speakers to appear, one of which was a Nobel Laureate.

The discussions in class sensitised students to the world and opportunities in Zambia. The course inspired students to define their own student projects, benefiting from the use of Internet resources. In particular, EVOINT motivated students to use internet to search for information for their Final Year projects, despite the constraints of little or no internet connectivity for students at UNZA. Through LinkNet implementations, UNZA students could access the internet even in remote places. For example, students accessed internet resources for a biofuel project from inside the chiefdom of Chikanta, in rural Zambia.

EVOINT highlighted the handicap of the severely constrained bandwidth at the university. Sensitised to the opportunities and possibilities, and utilising online tools of interactions, undergraduate students implemented their own wireless network on UNZA campus - copying LinkNet experience from rural Zambia. Students paid for their own, high internet connectivity costs.

During EVOINT, most students got their first 'hands on' experience in using Facebook for academic purpose. After class, discussions continued one-on-one via Internet and Skype. Students involved in the lecture series benefited much. The quality of presentations and written reports improved, and a few participants secured outstanding results, with one student gaining recognition through winning an award for engendering innovation in agriculture.

A VISION FOR ACADEMIC ICT EDUCATION AND RESEARCH IN SUB-SAHARA AFRICA

The revolution in the education system presents new challenges to established universities. At the same time, it can provide solutions to the obstacles that African universities are facing in developing ICT education. ICT could mediate the challenge of African academics to both positioning culturally close to the African society and to linking intellectually to wider scholarly and scientific values of the world of learning (Mazrui, 2003). In Africa, EVOINT can provide contributions to overcome Africa's legacy of Western-centricity by integrating and reviewing ICT utilizing ethnography, storytelling and trans-disciplinarity.

This contributes to the need of African universities as Mazrui (Mazrui, 2003) put them:

1. de-colonizing modernity by the African university seeking cultural nearness to African society;

2. diversifying the cultural content of modernity, moving the African university from a multi-national corporation to a multi-cultural corporation;
3. installing an African flow of influence into the Western civilization.

Further, the openness of the Internet, and EVOINT discussions, would support the thrust for more symmetric University partnerships, which are currently asymmetric (Holm and Maleté, 2010).

Starting from a 'greenfield' situation provides an opportunity to leapfrog the development, taking advantage of the possibilities of ICT to align with priorities as set by national policies. It provides opportunities to explore traditional African views and their allegiances, and expose the unique cultural, political, economical, and social context in Africa to the World. It allows enhanced, informative and implementable indigenous science and applied research also from within rural African communities.

The lack of excellent lecturers in ICT can be overcome (at least to a great extent) by making use of the wide spectrum of available online lectures of high quality. These online courses must be accompanied by coaches helping students to put together their palette of courses, monitoring progress, and adjusting the process along the way, as desired.

Online lectures in various disciplines must be complemented by meeting in class where a professor discusses with the students the inter-relations between the various aspects of ICT. In these classes, much attention must be given to the role of technology in society and to ethical aspects. The content must be placed within the context of the culture of society. That way, students may be prepared for any future role in which they have to show leadership in applying ICT for the development of the society.

Online lectures and interactive work in classes must further be complemented with practical work, such as:

1. team work, for instance groups of students developing specific applications or apps for smart phones,
2. work in practical situations, for instance in living laboratories as in Macha, Zambia, or Murambinda, Zimbabwe,
3. working on business plans which may lead to actual start-up companies.

In Africa, a new wave of development can be observed around ICT and mobile web. ICT provides the means for close co-operation in regional networks in order to share resources, share experience and for mutual inspiration. Such co-operation should ideally cover education and research, as well as applied research and innovation leading to new jobs and new businesses. Close co-operation with the emerging hubs of innovation is highly recommended. The future of the university requires integration of research, education, innovation and entrepreneurship development.

CONCLUSION

The coming years will bring unprecedented changes to existing educational systems. Digital skills and web-science will take a prominent place in the curriculum. Blended learning using Information and Communication Technologies will be the preferred educational model. New technology will bring about a new type of networked university. Such university will be characterised by a trans-disciplinary approach, engage with communities on the communities' terms, seek solutions that mediate local details with global positions, embrace diversity and multiple perspectives, with attention for ethical aspects, research skills and entrepreneurship development for students.

The new technology and insights into educational processes provide promising opportunities for academic development in Africa, leading to full inclusion of African scholarship in the global community of science and innovation, and enabling the rest of the world to benefit from contributions based on African wisdom and culture.

Three years of experience with the course 'The Evolution of the Internet' has demonstrated the importance of the holistic webscience approach to ICT education and the vast potential of ICT and social media to empower the education process.

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