

# Capacity Development supported by ICT in Higher Education

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**Abstract:** This paper focuses on the question how ICT in higher education can play a role in capacity building and development in developing countries. A general framework distinguishes two mechanisms through which ICT aids the capacity building process; in the first, ICT has a supportive role while in the second mechanism, ICT is a capacity building tool in itself. Three different phases throughout the education and capacity building process can be identified. A case study of Master students at a European Master programme further explores and specifies the general framework. The different methodologies, technologies and developments are discussed along the lines of the three different periods.

**Keywords:** Capacity Development, ICT, eLearning, eAdoption.

## 1. Introduction

During the opening address at the first phase of the World Summit on the Information Society (WSIS) in Geneva, December 2003, Secretary General of the United Nations Kofi Annan proclaimed that "...[w]e are all familiar with the extraordinary power of information and communications technologies. From trade to telemedicine, from education to environmental protection, we have in our hands, on our desktops and in the skies above, the ability to improve standards of living for millions upon millions of people." As the UN ICT Task Force suggests, the implementation of national e-strategies can be regarded as a critical enabler in the development process, while ICT offers an opportunity to leapfrog some stages of development [1].

The Millennium Development Goals (MDG's) serve as an important guide and indicator for progress made towards different aspects of development. All eight MDG's can be supported, facilitated or complemented with ICT. The UN ICT Task Force [1] argues that "[r]ecent developments in technologies, reduction in prices, greater availability of networks and a more user-friendly approach to technologies are strengthening the role that ICT can play in support of development." According to Hall & Dijkman [2], capacity development approaches should not only focus on transfer of knowledge. "The failure to develop complementary competencies and structures to put that knowledge into use and the need to take account of both scientific resources integrate with the rest of the economy and to respond to society as whole is now of major concern in the science, technology and innovation." [2] In every aspect of development, ICT can play a role and form a means to an end [3].

In this paper, we will specifically focus on the following question: How can the use of ICT in higher education play a role in capacity creation and development in developing countries? First, a general framework is created in which we can place the role of ICT in

higher education in the bigger picture of capacity building and development. Second, we will clarify and support our arguments by using a case study from the Maastricht Graduate School of Governance (MGSOG). With respect to this case study, we discuss the various methods and technologies used as well as future opportunities and developments.

## **2. Objectives**

When discussing the use of ICT in higher education and its role in capacity creation and development in developing countries, we can distinguish two different mechanisms and three different stages throughout the process. In the first mechanism, ICT can be considered to have a supportive role in the capacity building process while in the second mechanism ICT in itself presents a capacity building tool.

Furthermore, these two mechanisms take place in three different phases throughout the process of education and capacity building. Firstly, students can be given an option to fill knowledge deficiencies that might exist before the start of an educational programme in order to be able to benefit from the programme to its full potential. During the second phase, students follow and participate in the specific teaching programme and finally, after completion of the programme, their knowledge and skills are disseminated in the graduates' direct surroundings to support further capacity building. Throughout the discussion of the general framework, we take the viewpoint that students originate from developing countries and follow an educational programme at a European institute.

### *2.1 Two mechanisms*

The first mechanism that can be distinguished when considering capacity creation and development focuses on the supportive role of ICT. By making ICT tools and technologies an integral part of the educational programme, the programme can enhance its innovative and instructive character [4]. New possibilities are created to meet students' needs and to place materials in its context [5]. Online remedial teaching, adaptive courses, collaborative and blended learning are examples of new possibilities that can aid the learning process. The first mechanism creates better opportunities for students to absorb new skills and knowledge in their field of studies and therefore to foster capacity development for the individual in the short term as well as institution- and community-wide in the longer run.

The second mechanism to be distinguished concentrates on the direct role ICT itself plays in the capacity building process [6]. Throughout the educational process, students are faced with different tools (referring to the examples of new possibilities as mentioned above) and technologies in the ICT sphere that will directly enhance their ICT skills. The exposure to ICT familiarizes the students with possibilities and advantages that they can also implement in their future field of work. Once graduated and after return to their home country, the students can apply and implement their ICT skills and directly build capacity in the form of e-adoption, e-governance and in specific cases e-government.

### *2.2 Three stages*

The capacity building process through education can be divided into three different stages. In every stage, ICT can fulfil a supportive and direct role.

#### **2.2.1 Before the start of the educational programme (at the student's residency)**

Before starting the programme, prospective students can fill existing knowledge deficiencies that might hamper them to benefit from the educational programme to its full potential. This can be done by means of online remedial teaching, adaptive courses and a combination of distance learning with face-to-face education (blended learning), whereby ICT is supportive with respect to capacity creation. An advantage of using these tools is that it can significantly reduce the costs for students as compared to following a remedial course

at the educational institute itself. Since students are exposed to ICT and its usage during this phase, capacity building in the area of e-adoption and possibly e-government and e-governance is already set in motion before the educational programme has started. Hence, ICT directly plays a role in capacity building and development.

### *2.2.2 During the educational programme (at the educational institute)*

Throughout the course of the educational programme, students employ different tools and educational methods to gain knowledge and skills in the subject matter. A good understanding of the programme's concepts, practice and competence in various skills and a successful completion of the programme are prerequisites for a capacity building process in the specific subject. To ensure the existence of these prerequisites, ICT can play a supportive role by means of blended learning, a virtual learning platform and making the programme more interactive. Furthermore, by using the various tools, students will learn even more ICT competences that directly build their skill level in ICT.

### *2.2.3 After completing the educational programme (back at the student's residency)*

Once students have successfully completed their programme, they will use and implement the newly gained knowledge and skills. After building their own individual capacity, graduates can play a crucial role in capacity building of an institution, sector or community. Their main basis to do so is the programme's content and subject. However, capacity creation and development does not only take place in the subject of the educational programme but also in ICT due to the graduates' exposure during the first two phases of the process. They have learned how to use it, its advantages as well as disadvantages and how it could be useful in their own field of work. These graduates can provide a backbone for further e-adoption, e-governance and in specific cases e-government.

## **3. Methodology**

The general framework as set out above can be further explored by means of a case study from the Maastricht Graduate School of Governance (MGSOG), Master programme in Social Protection Financing. The applicants are primarily professionals from developing countries, in particular from Africa and Asia. The majority gained work experience at a public or semi-public institute in the field of social security after having completed a bachelor degree several years before. Stimulated by organisations like the International Labour Office or their own institute, and funded by a series of different scholarships, these professionals decide to follow a Master programme in Europe in order to build up knowledge and skills. Upon return, the newly acquired knowledge and skills can be disseminated in their institute to develop and enlarge its capacity.

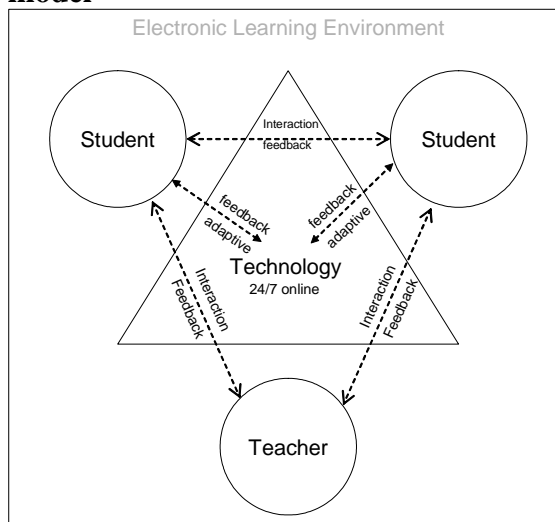
The case study focuses on a relatively small but extremely diverse and international group of students in the Master programme in Social Protection Financing (SPF) in the academic year 2005-2006. The case study will be discussed along the lines of the three different phases identified in the general framework. The experiences at MGSOG can be used as a showcase for the use of ICT in capacity building and e-adoption as well as e-governance.

### *3.1 Phase 1: Online Summer Course Mathematics*

According to Van Leijen et al. (2004) [7], "traditional" face-to-face remedial teaching programmes have not been successful in terms of completion rates. This is partly due to the "incentive problem". Students have a strong preference to do other activities besides studying. Online courses might solve (part of) this incentive problem because it offers flexibility to students when and where to study [8]. Moreover, online courses can reduce costs for students as they can stay in their home country.

As indicated by the results of online pre-assessments, most students taking part in the Master programme had limited knowledge about subjects like mathematics. Therefore, they were asked to fill their knowledge deficiencies before the start of the academic year. In order to allow a smooth transition into the academic master level, an online remedial course in mathematics was offered for 25 (prospective) master students of the Social Protection Finance programme in the summer of 2005. This remedial teaching programme took place entirely online, thereby recognizing the supportive and direct role ICT can have in capacity building.

**Figure 1: Online remedial teaching model**



Source: Rienties, Rehm & Dijkstra (2005).

In a model developed by Rienties, Rehm and Dijkstra (2005) [8], five main aspects of an effective online remedial teaching model are presented. This model was tested in practice for remediating prior knowledge deficiencies in economics and mathematics for one hundred (European) bachelor students. In their model, five elements of an online remedial teaching model are: 1) accessible & available 24/7 online; 2) adaptive; 3) interactive; 4) rapid feedback and 5) flexible learning methods and assessment. If the programme is accessible 24/7 via Internet, students can access relevant information and communicate with each

other at a time of their preference. In addition, if the programme is adaptive, differences in pre-knowledge, learning behaviour and learning styles are taken into consideration. Hence, each student receives an individual training via ICT. It is crucial to have interaction between student and technology on the one hand and between student and teacher on the other hand. Furthermore, Vrasidas en McIsaac (1999) [4] argue that feedback is of utmost importance for interaction in an online course.

### 3.2 Phase 2: Master programme in Social Protection Financing

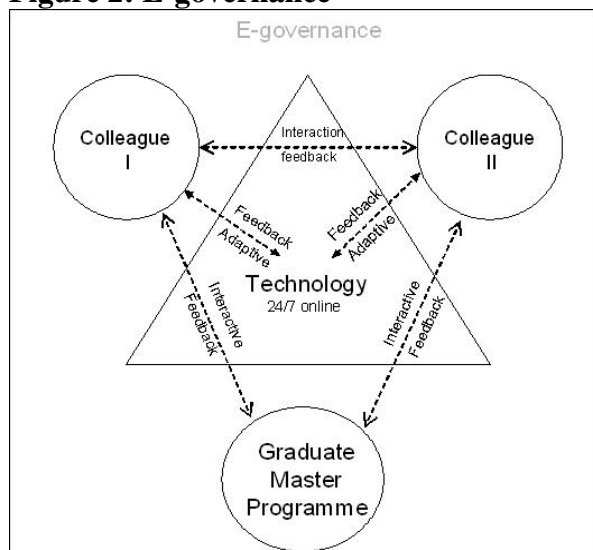
This one-year Master programme trains professionals in social protection and in social protection financing for social security institutions, insurance companies, governments, research institutions and consultancy companies. The different topics discussed include various social policy and protection schemes that affect people in different periods of their life cycle. Their history, goals, implementation and means of financing are dealt with. Social protection affects all in society and has an enormous impact on the standards of living, thereby also making the programme highly relevant for developing countries.

MGSOG uses various forms of educational methods at different stages in the study programme to transfer skills and knowledge to the students, ranging from classical teaching, problem-based and project-based learning to blended learning. Each course is supplemented with and supported by a Virtual Learning Environment (VLE). According to Roblyer and Wiencke (2003) [5], virtual learning environments that effectively make use of communication and interaction tools will offer unique opportunities to engage students and gain learning results. This, as discussed in the general framework, will ensure the existence of the necessary prerequisites that make capacity building possible.

### 3.3 Phase 3: Capacity building upon return to home country

After graduation, students will return to their home country and often to their former jobs in semi/public institutes. In this phase, the process of capacity creation and development can be extended from an individual to the institutional level. Graduates can transfer their knowledge and skills of social protection (through the supportive role of ICT) as well as ICT skills (through the direct role of ICT). The latter can create possibilities for e-adoption, e-governance and in specific cases for e-government.

**Figure 2: E-governance**



According to Odendaal (2003) [6], the three success factors of achieving e-governance are integrated delivery of required ICT infrastructures, sufficient capacity and adequate training. As the graduates will have experience with ICT, they have become skilled and should be able to transmit skills and knowledge. Furthermore, they can use their knowledge and skills to convince local institutes of (potential) usefulness of ICT. The trained graduate can enhance capacity building of his/her direct colleagues. In a way, the graduate becomes the teacher in the previous model, and

the two students are replaced by their colleagues as is illustrated in figure 2.

## 4. Technology Description

### 4.1 Phase 1: Online Summer Course Mathematics

Students worked with an online commercial programme called ALEKS (<http://www.aleks.com/>), which assesses the pre-knowledge level of students and offers a unique individual learning path afterwards. The programme was based on Knowledge Space Theorem [9]. Firstly, a student had to make an online entry (diagnostic) test in order to assess his/her pre-knowledge of mathematics. The online test was adaptive, meaning that a student was given a different question depending on the answer given on the previous question. Afterwards, a unique learning path was offered to the student depending on his/her pre-knowledge. If a student went faster (or slower) through the learning materials, the programme immediately adapted the learning path. Students had to solve mathematical problems and if necessary ALEKS provided hints. If the student was still unable to solve the problem, then a teacher could be contacted [10]. In other words, the programme is in line with the online remedial teaching model in section 3.1.

### 4.2 Phase 2: Master programme in Social Protection Financing

As described in section 2.2, several educational formats are used throughout the Master programme. Nevertheless, the focus lies on small-scale education, albeit face-to-face or online education. Blended learning in the programme is supported by the Electronic Learning Environment University Maastricht (ELEUM). At Maastricht University, the standard system used as virtual learning environment is Blackboard. Furthermore, Rienties et al. [8] argue that "... the functionality of Blackboard is in line with the five aspects described in the online remedial teaching model". In principle, the system combines various

content-management systems with some communication and assessment tools. For example, it is possible to let students do quizzes and give immediate feedback on their results and learning process. In addition, the VLE has various interactive communication tools like discussion-boards, E-mail or chat.

#### *4.3 Phase 3: Capacity building upon return to home country*

According to Oyelaran-Oyeyinka and Adeya [11], ICT within an institution in a developing country is mainly used for basic level computing like text processing or E-mail. It is fair to say that ICT infrastructures are not as well developed as in Europe, where the students gained their ICT skills [11]. Therefore, upon return, the graduates will have the upper edge in ICT skills.

## **5. Results**

Assessing the results can only be done for the first phase of the education and capacity building process. Because phase 2 takes place at the moment and phase 3 will occur in the future, we can only make fair assumptions about the likely outcomes and thereby attempt to answer the question on the role of ICT in higher education.

#### *5.1 Results phase 1: Online Summer Course Mathematics*

In total 12 out of 25 students that started with the Mathematics programme completed it successfully. At the end of the online remedial teaching programme, an online evaluation was conducted, which is based on an evaluation protocol for flexible learning developed by Kaper et al. [12]. Considering that the response rate of the master students was relatively low (those who failed the course did not fill in the evaluation), we have included (part of) the results of the evaluation of bachelor students following the same summer course in table 1.

As is clear from table 1, the differences between bachelor and master students are marginal. Both bachelor as well as MGSOG students were very positive about the summer course and the use of ALEKS. The students indicated that the course offered them a possibility to make a successful start at Maastricht University and to receive better results during the course of their study. With regard to the Virtual Learning System, the students were highly satisfied with ALEKS with regard to user friendliness. In addition, students were very positive about the quality of the educational material. On average, the students estimated that they worked around 65 hours.

Table 1 Evaluation of Online Summer course Mathematics

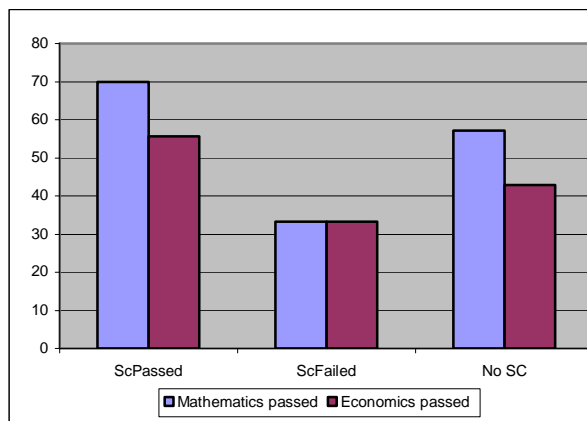
	Bachelor	MGSOG
	N=21	N=9
This Summer course offered me a lot	4.6	4.5
The format of the Summer course was good	4.4	4.3
The quality of the material in ALEKS is good	4.3	4.4
The material in ALEKS motivated me to keep up with the subject matter	4.0	4.0
The contents of the Summer course fitted well with my pre-existing knowledge	3.9	3.8
The assignments/tasks stimulated me to study	4.1	4.4
I gained enough knowledge and skills in mathematics to start with my study in Maastricht	3.7	3.9
I think that by attending this Summer course I will get better results in my future study in Maastricht	3.9	4.2
It is easy to understand how to operate in the ALEKS learning environment	4.6	4.6
It was good that I could work on the subject matter at my own pace	4.6	4.6
It was easy to motivate myself to finish this Summer course	3.8	3.6
Give an overall grade for the quality of support you were given by ALEKS in this Summer course (1 = very bad - 10 = very good)	8.6	8.9
Give an overall grade for the quality of this Summer course (1 = very bad - 10 = very good)	8.8	9.0
In total, I spent .... hours on this Summer course	67.3	64.1

Note: Except from last 3 questions, all other questions on Likert scale (1 = totally disagree – 5 = totally agree)

## 5.2 Results phase 2: Master programme in Social Protection Financing

During the first course period in September/October 2005, students followed a face-to-face intermediate mathematics and economics course. The results of the exams indicate that the group of students, who passed the summer course (ScPassed=10), outperformed the group of students that did not pass (ScFailed=3) or did not take part at all in the summer course (No Sc=7), as is illustrated in figure 3.

Figure 3: Passing rates Math & Economics courses (in %)



Besides higher passing rates, the ScPassed group also attained higher grades for both courses in comparison to the ScFailed and No SC group. This might be partly due to a "motivational effect". One can assume that the summer course students that passed are also students that are more motivated. These results are not conclusive due to its small sample size but can provide us with an indication of the expected progress in phase 2 of the capacity building process.

Moreover, similar effects have been found by Tempelaar et al. [10] for the group of bachelor students taking the summer course. Therefore, there seems to be a rough indication that the refreshment course leads to positive learning effects in the regular curriculum. This was also confirmed by a qualitative evaluation by means of personal interviews conducted two months after the online course. The interviews provided a more thorough analysis of the structural learning effects and reflect the overall results of the quantitative online evaluation (listed in table 1). In other words, students are more likely to complete the Master programme successfully if ICT is used in its supportive role.

### 5.3 Results phase 3: Capacity building upon return to home country

The results of capacity building upon return are inconclusive at this point in time. From our line of reasoning and results in phase 1 and, partly, phase 2, one could argue that capacity creation and development is enhanced by the use of ICT. ICT is supportive in capacity creation with respect to content and skills in social protection and directly fulfils a role in e-adoption and e-governance in the home country.

## 6. Business Benefits and Conclusion

This paper analysed the role of ICT in higher education in capacity creation and development in developing countries. Two different mechanisms were identified through which ICT can play a role in capacity building. The first mechanism refers to the supportive role ICT plays and how it can enhance the innovative and instructive character of the educational programme. The results of the online remedial teaching summer course in mathematics portrayed that students believed they were prepared for a successful start of their Master programme. The students that passed the online summer course also outperformed the students that either failed or did not participate in the summer course on the exams of the intermediate mathematics and economics courses.

The second mechanism concerns the direct role that ICT takes in capacity creation. As argued above, the ICT skills that students gain during the online summer course and throughout the Master programme can promote e-adoption and e-governance upon return to the home country. The graduates can act as teachers in the online remedial teaching model and teach their colleagues about the benefits of ICT. The expected benefits of training professionals in the public and semi-public institutes are increasing affinity with ICT in general and e-adoption in particular.

Further research [13] is needed in order to assess whether the positive results of the online summer course in the first phase and of the intermediate courses in mathematics and economics in part of the second phase will prevail throughout the Master programme. The current students will continue to be followed during and after their study programme. In addition, the online summer course will be offered to a new and larger group of prospective students in 2006 and will be extended to other fields besides mathematics (e.g. economics, political science) in order provide more capacity building and to verify the external validity. Finally, collaboration with partners from the South is envisaged to investigate whether parts of the programme can be offered in blended form at a student's home country.

## References

- [1] UN ICT Task Force. (2003). *Tools for development: Using Information and Communication Technologies to achieve the Millennium Development Goals*. New York. New York. December 2003.
- [2] Hall, A. & Dijkman, J. (2006). Capacity development for agricultural biotechnology in developing countries; Concepts, contexts, case studies and operational challenges of a systems perspective. *United Nations University-MERIT Working Paper Series*, 2006-003, Maastricht, The Netherlands.
- [3] UN ICT Task Force. (2005). *Innovation and Investment: Information and Communication Technologies and the Millennium Development Goals*. New York, April 2005.
- [4] Vrasidas, C., MC Isaac. (1999). Factors influencing interaction in an online course. *The American Journal of Distance Education*. 13 (3). 22-36.
- [5] Roblyer, M., Wiencke, W. (2003). Design and use of a rubric to assess and encourage interactive qualities in distance courses. *American Journal of Distance Education*. 17 (2). 77-98.
- [6] Odendaal, N. (2003). Information and Communication Technology and Local Governance: Understanding the Difference between Cities in Developed and Emerging Economies. *Computers, Environment and Urban Systems*. 27. 585-607.
- [7] Van Leijen, M., Wieland, A., Rienties, B. et al. (2005). *Quick scan onderzoek naar de initiatieven elders*. (Quick Scan research of remedial teaching initiatives). Universiteit van Amsterdam, Universiteit Maastricht, Erasmus Universiteit Rotterdam.

- [8] Rienties, B., Rehm, M., & Dijkstra, J. (2005). Remedial online teaching in theory and practice; online summer course: Balance between summer and course. In H. Goss (Ed.), *Balance, fidelity, mobility: Maintaining the momentum?* Proceedings of the 22nd Annual Conference of the Australasian Society of Computers in Learning in Tertiary Education. Brisbane: Teaching and Learning Support Services, Queensland University of Technology. 569-576.
- [9] Doignon, J.-P. & Falmagne J.-Cl. (1999). *Knowledge Spaces*. Springer. Berlin.
- [10] Tempelaar, D., Rienties, B., Rehm, M., Dijkstra, J., Arts, M., & Blok, G. (2006). An online summercourse for prospective international students to remediate deficiencies in Math prior knowledge: the case of ALEKS. Presented at WebALT 2006 Conference, Eindhoven, the Netherlands.
- [11] Oyelaran-Oyeyinka, B., Adeya, C. (2004). Dynamics of Adaption and Usage of ICTs in African universities: a study of Kenya and Nigeria. *Technovation*. 24. 841-851.
- [12] Kaper, W., Blok, G., Brouwer, N., & A. Wieland. (2005) *Evaluatieprotocol voor flexibel onderwijs bij heterogene instroom*. Universiteit van Amsterdam, Universiteit Maastricht, Erasmus Universiteit Rotterdam.
- [13] Hall, A. (2002). Innovation systems and capacity development: an agenda for North-South research collaboration. *International Journal of Technology Management & Sustainable Development*, 2002, Vol. 1 (3), 146-152.