Lecture Notes in Educational Technology

Ronghuai Huang
Kinshuk
Jon K. Price *Editors*

ICT in Education in Global Context

Emerging Trends Report 2013–2014

Springer

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This work is organized by Collaborative and Innovative Center for Educational Technology (CICET), which is jointly supported by China's Ministry of Education and Intel Corporation.

ISSN 2196-4963 ISSN 2196-4971 (electronic)
ISBN 978-3-662-43926-5 ISBN 978-3-662-43927-2 (eBook)
DOI 10.1007/978-3-662-43927-2

Library of Congress Control Number: 2014943123

Springer Heidelberg New York Dordrecht London

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Foreword

This volume addresses information and communications technology (ICT) in a global context, reporting emerging trends and issues in four areas: (a) basic education, (b) technical and vocational education, (c) distance and continuing education, and (d) higher education. These four areas represent the primary contexts in which ICT is used to support learning and instruction. It is no surprise that technology is changing how education is conceptualized, designed, and implemented around the world. Innovations in technology lead to innovations in education. Nonetheless, the essential nature of learning remains relatively constant in the sense that learning involves stable and persistent changes in what a person knows and can do. While the changes in ICT have been quite dramatic in the last 20 years, the changes in education have been much less dramatic. Education is not being radically reformed on a large scale. Rather, changes in education are usually being introduced in an incremental fashion in spite of the exaggerated rhetoric about the complete transformation of learning and instruction. These incremental changes are likely to result in large-scale transformations, but those transformations take time and effort to be realized.

Teachers and instructors have been trained to support traditional models of learning and instruction that have established records of effectiveness. One aspect of large-scale transformation is the reality of existing schools and teacher/instructor training programs. One cannot expect those to be changed in significant ways overnight, and the changes that are occurring require new ways to organize schools, prepare teachers and trainers, and plan for continuing changes in technology. Given these requirements, dramatic changes are not as likely as incremental changes.

Among the promising affordances of new and emerging technologies are the ability to (a) provide meaningful and timely online assessments of complex problem-solving skills, (b) support ongoing and further education in many different locations, timeframes, and contexts, and (c) create new and innovative ways to design, develop, and deploy support for learning for a wide variety of subjects and a diverse population of learners. Many such efforts around the world are reported in this volume as representative of the kinds of gradual transformations that are likely to continue in the coming years.

The unspoken question that remains unanswered is not whether education can be transformed through information and communication technologies to significantly improve learning and instruction in different contexts on a large scale. Education can be improved and technology can be and will be a catalyst for improvement. The question that remains is the willingness of organizations, schools, and society to commit the resources and support necessary to make substantial and sustained improvements in learning and instruction. It is clear that a few organizations and schools are already making such commitments. A few nations are beginning to see that a well-educated citizenry is a path to peace and prosperity. However, there are many obstacles yet to be overcome for ICT to have the impact on learning and instruction that is envisioned by so many dedicated educational researchers and instructional technologists. Among those obstacles are the willingness to commit the necessary resources to promote and support change and the political and social will to place primary emphasis on education. It is not clear what the landscape of education in these four areas will be in 10 or 20 years. One can only hope that such efforts as those represented in this volume will lead to productive and meaningful transformations.

April 2014 J. Michael Spector

Preface

Rapid advances in technology have revolutionized the way in which children learn, play, communicate, and socialize. During the past years, the increased interest in applying digital technologies aiming to improve learning and teaching has led to significant growth in research and practice of ICT in education. Several national policies, cutting edge research, and practices worldwide are aiming at leveraging digital technologies to promote the infusion of ICT into education and meeting the twenty-first century life-long learning societal needs. To this end, this book aims to capture the current advances and emerging trends of digital technologies for learning and education through a number of invited chapters in key research areas.

The book is structured into four parts.

Part I: ICT in Basic Education

The first part of the book consists of seven chapters. The focus of this part is on the integration of ICT in schools. Countries throughout the world have established different national strategies for integrating ICT in their schools. Rosa Maria Bottino examines the situation in Italy, focusing in particular on the national plan for digital schools and on some of the projects that have been launched under this umbrella. The chapter reports some of the initial outcomes of the plan, which is presently underway, and looks at various strengths and weaknesses taking into account a review of this plan made recently by the Organisation for Economic Co-operation and Development (OECD).

Dermod Madden introduces the inclusive education in rural Alberta, Canada to show how they have utilized ICT to support twenty-first century learning.

Jon Price, Daniel Light, and Elizabeth Pierson highlight the research on six assessment strategies that should be part of a twenty-first century learning

environment and encourage ministries to consider how these strategies may play a role in their own reform efforts. These strategies include rubrics, performance-based assessments, portfolios, student self-assessment, peer-assessment, and student response systems.

Daniel Light and Elizabeth Pierson focus on the experience of two Russian schools that are using laptops in everyday instruction to explore how educators are enriching and transforming Russian educational practices. After examining the approaches of using laptops in the two Russian schools, the authors propose some common elements supporting their success.

Di Wu focuses on the status, problems, targets, key measures, and experiences of ICT in education in China, and introduces a series of measures such as "three connections and two platforms," "full coverage of digital education resources in teaching sites," and "teacher training," adhering to the core idea of deep integration between ICT and education.

Chee-Kit Looi and Wenting Xie elaborate and discuss two succinct examples of innovations adopting the design-based research approach that has shown promises of impact on classroom practices, on student learning, and of being able to be sustained and scaled to broader contexts.

Vassilios Makrakis discusses ICTs potential as a transformative tool in teaching and learning with focus placed on sustainability education. He argues that ICTs offer opportunities for educators, but there is a need for professional development as perspective transformation, a process whereby prospective teachers critically examine their beliefs, assumptions, values, and personal theories as they learn technologies and acquire new knowledge and experience.

Part II: ICT in Technical and Vocational Education

The second part of the book consists of three chapters, focusing on ICT in technical and vocational education.

Alke Martens, Nils Malzahn, H. Ulrich Hoppe propose pattern-based approaches to introduce new technologies in vocational training by empowering teachers to better manage and share web resources in their teaching. Issues of organizational culture and change management turn out to be decisive for the success of such approaches.

Anup Kumar Ray analyzes available data to identify causes of poor access, equity, and quality in higher technical education system in India, and examines the effects of the policy measures taken to address these issues.

Panagiotis Zervas, Konstantinos Chatzistavrianos, Demetrios G. Sampson focus on modeling teachers' ICT competence profile in Europe by considering existing teachers' ICT competence frameworks and selecting the most appropriate one. They also focus on describing, in a machine readable way, the proposed teachers' ICT competence profile by exploiting existing specifications for competences description.

Part III: ICT in Distance Education

The third part of the book consists of two chapters dealing with ICT in distance education.

Rob Koper presents a case study of a business model change of the Open University of the Netherlands in the period 2008–2013. The implementation of the business model is discussed in terms of adaptations in course development (including the use of open educational resources), course delivery, ICT infrastructure, and a revised model for the implementation of innovations.

Carlos Villanueva and Marcia Ortega address three examples of success cases in distance education within (a) an important financial group with presence in Latin America and Spain; (b) a non-governmental organization based in Europe; and (c) a government department in an African country, through programs jointly designed with a prestigious Mexican higher education institution.

Part IV: ICT in Higher Education

The fourth part of the book consists of three chapters focusing on ICT in higher education.

Okhwa Lee and Yeowook Im present the current trends of ICT in higher education including the new pedagogy for digital teaching and learning, utilization of smart technology for higher education, globalization of e-learning in higher education, and open educational resources.

Toshio Okamoto, Fumihiko Anma, and Naomi Nagata discuss the framework for e-Learning 2.5 and its primary functions through the organizational knowledge circulated management on e-Learning.

Marmar Mukhopadhyay and Madhu Parhar introduce several major initiatives in integrating ICT in management and administration of higher education led by the University Grants Commission in India.

In conclusion, we hope this compilation would benefit learners, educators, scholars, and trainers by providing them an insight of the emerging trends of ICT in education.

We would like to express our gratitude to all those who provided support, talked things over, read, wrote, offered comments, allowed us to quote their remarks, and assisted in the editing, proofreading, and design.

Ronghuai Huang
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Contents

Part I
ICT in Basic Education

Chapter 1
ICT as a Catalyst of Innovation

Opportunities and Critical Issues in Italy's Strategy for Digital Schools

Rosa Maria Bottino

Abstract Research in educational technology has revealed that technology can be an important resource for the quality of teaching and learning processes both for the learning of disciplinary contents and for the acquisition of transversal cognitive competencies. However, many research studies have also demonstrated that new technologies only have an impact on teaching and learning processes if there is co-evolution of ICT and schooling. This co-evolution should entail novel educational strategies, pedagogical activities, and roles in which teachers and students are both actively involved, as well as development of educational institutions' general organization and policies. Change at this level is extremely challenging; it involves numerous changes in educational practices and resources, as well as in educational policies. Countries throughout the world have established different national strategies for integrating ICT in their schools. This paper examines the situation in Italy, focussing in particular on the national plan for digital schools and on some of the different projects that have been launched under this umbrella. The paper reports some of the initial outcomes of the plan, which is presently underway, and looks at some of its strengths and weaknesses taking into account a review of this plan made recently by OECD. A few exemplary experiences carried out in recent years are also discussed with the aim of identifying positive indications and possible interesting developments.

Keywords School innovation · Digital schools · ICT policies in education · Technology-enhanced learning · Learning environments

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R. Huang et al. (eds.), *ICT in Education in Global Context*,
Lecture Notes in Educational Technology, DOI: 10.1007/978-3-662-43927-2_1

1.1 Introduction

Research in the field of educational technology (generally known in Europe as Technology-Enhanced Learning or TEL) has revealed that technology can be an important resource for enhancing the quality of teaching and learning processes. This is true both for the learning of disciplinary concepts, e.g. in science or maths, and for the acquisition of transversal cognitive competencies. However, many research studies have demonstrated that an effective impact on education can only be obtained if technological innovation develops together with pedagogical innovation (Guzman and Nussbaum 2009, Bottino et al. 2009).

Notwithstanding the considerable public funds invested to equip schools with hardware and software and the positive experimental results produced in research projects, the high expectations about technology potential to drive change and innovation in schools appear to have remained largely unfulfilled at the level of mainstream school practice (Venezky and Davis 2002; Sutherland 2004).

The possible reasons for this outcome are various, ranging from traditional resistance to change by school systems and teachers alike, to reasons more deeply related to the fact that technology has often been introduced as an addition to an existing, unchanged classroom setting (De Corte 1996; Grasha and Yangarber-Hicks 2000) and that large implementation gap remains (Eurydice 2011). Of course, national policies and the general guidance provided by national governments on the introduction of Information and Communication Technologies (ICT) in schools have had a key role in this regard.

At the beginning, many countries invested considerable funds in the provision of ICT infrastructures (PCs, internet connections, etc.) to schools and in providing teachers with basic ICT knowledge and skills.

However, this investment did not lead to wide-scale take-up of ICT for enhancing teaching and learning processes. In cases where ICT did enter teaching practice, it generally led to superficial changes that brought little real innovation to the foundations of schooling: syllabuses, methodological approaches, content knowledge, relational dynamics, organisational aspects, etc. (Bottino and Furinghetti 1999; Bingimlas 2009). Indeed, only when ICT adoption is accompanied by a parallel evolution in education as a whole it can have a real impact on teaching and learning processes and act as a catalyst of innovation (Collins and Halverson 2009).

Co-evolution of ICT and schooling leads to increased organisational and management complexity (Davis et al. 2011) and is extremely challenging, requiring numerous changes to educational practices and resources, as well as to educational policies. If these changes do not happen, even innovative schools may drop back from effectively embedding ICT (Eickelmann 2011; Law et al. 2010).

Consequently, there is a strong case for analysing specific instances in which ICT in education is concretely supported by national policies. These cases should prove useful both for investigating emerging trends and for identifying critical issues.

In this paper, the specific case of Italy will be considered and discussed. In particular, reference will be made to the Italian national plan for digital schools

(MIUR 2012) and to two specific projects that have been launched under this umbrella. Some strengths and weaknesses of these projects are briefly considered and analyzed, along with the discussion of some aspects put forward in a recent review of the plan carried out by the OECD (Avvisati et al. 2013).

1.2 The Italian Strategy for Introducing Ict in Schools

1.2.1 The Past

Italy's first national initiative for ICT in education was the 'National Plan for Informatics' launched in 1985. It was devoted to the professional development of mathematics and science teachers in upper secondary schools, aiming to update their content knowledge to include elements of informatics. This training plan was enacted through courses for teachers in which traditional face-to-face lessons alternated with computer practice. The method used was 'pull-down', i.e. the training programme was operated through trainers who are in-service teachers specifically trained for the purpose.

In the early 1990s, the 'Programme for the Development of Educational Technologies' offered funding support to schools for acquiring technological equipment and for the professional development of teachers. The schools were granted autonomy in both their equipment choices and teacher training initiatives. A total of 13,300 schools were involved between 1997 and 2001.

In 2000, a large-scale national programme for teachers' professional development was launched, targeting not only the development of ICT knowledge, but also its educational use (Schietroma 2011). This programme ('ForTIC') targeted 180,000 teachers of all disciplines, involving more than 20 % of the entire teacher population. A blended methodology was adopted, with each participant receiving approximately 12 h of training (six face-to-face plus six online).

An analysis of these initiatives (Bottino 2003) highlighted some general trends: (a) significant results were obtained in providing a considerable number of schools with a basic technological infrastructure (e.g. on average one computer for every ten students in secondary school, about 1/5 in technical schools to 1/25 in lyceums); (b) ICT equipment was mainly located in laboratories and access was seldom available from classrooms; (c) approximately half of the primary and secondary school teacher population was involved in ICT training initiatives, even if the quality and depth of that training varied widely; (d) the impact on teaching and learning methods and on teaching practice was limited; (e) a direct relationship could not be established between provision of infrastructure and ICT training on the one hand and effective pedagogical use of technology in schools on the other; (f) even when ICT use entered teaching practice, though with differing modes and characteristics, only superficial changes were observed that did not lead to innovation in syllabuses and methods.

It became more and more clear that the critical issues mentioned above called for careful consideration of the related difficulties and possible interventions, and for a clear support policy. In response, some national projects were launched to

provide teachers with examples of practice in which technology had been used to support the teaching of disciplinary topics. The main mission of these projects (e.g. 'Science and Technology—SET' projects, see: http://www.indire.it/set/) was to provide web-based repositories of primary and secondary school level teaching units that addressed curricular topics and integrated ICT. These projects had some positive outcomes: they generated direct collaboration between teachers and educational researchers in the implementation of the teaching units and provided interesting experiences for the teachers directly involved in the work. However, they failed to make a significant impact on a wider basis, due in part to their limited scope and budget.

1.2.2 The Current Situation

In 2007, a new national programme for large-scale introduction of ICT in schools, the 'The National Plan for Digital Schools' (Piano Nazionale Scuola Digitale) was launched with the aim of introducing ICT use directly into mainstream classroom activities; in this sense it represented a break from previous national efforts. The idea of isolated computer laboratories has been abandoned, and ICT adoption is considered equally relevant at all levels of education and for all subject areas (the STEM bias was dropped).

The national plan includes four main initiatives: a fund to equip classrooms with interactive whiteboards (Piano LIM), and three test-bed programmes in which pilot schools, selected through open competitions, are testing different ICT solutions (Cl@sse 2.0, Scuol@ 2.0, Editoria digitale scolastica (digital books for schools).

This paper looks in detail at two of these, Cl@sse 2.0 and Scuol@ 2.0, since in principle they have the greatest potential for introducing new teaching practices and new models of school organization. These initiatives are still in progress and are being carried out in successive implementation rounds. Consequently, the analysis and considerations reported in this paper are based on partial results and accomplishments.

The Cl@sse 2.0 programme started in 2009 for lower secondary schools and in 2010 for primary and upper secondary schools. It aims to support the creation of ICT-based learning environments that become a central part of daily school activities. Table 1.1 provides an overview of the budget invested by the central government in this initiative and of the number of classes involved. To gain funding, schools had to make a project application with a plan dedicated to embedding ICT in everyday class activities over a fixed number of years. Selected classes (maximum one per school) received funding for hardware, software and furniture.

The selection process was carried out at regional level and was largely based on the following criteria: the quality of the class project; the school's past experience with ICT projects; teacher preparation in ICT use; availability of broadband connectivity and the existence of additional funds to support the initiative. In total,

Table 1.1 Figures from the Cl@ss 2.0 programme for introducing ICT into Italian schools

School level	n° of selected classes	Budget invested	Years covered by the presented projects
Lower secondary	156	EUR 4.68 million (30,000 EUR each class)	3 (sixth grade to eight grade)
Upper secondary	136	EUR 2.04 million (15,000 EUR each class)	2 (ninth grade to tenth grade)
Primary	124	EUR 1.86 million (15,000 EUR each class)	3 (third grade to fifth grade)

over 4000 schools answered the Cl@sse 2.0 call and 416 were selected, corresponding to 0.13 % of all Italian school classes.

In each region, the schools involved were linked to a local university for support in integrating ICT in pedagogy, although the intensity of interactions between schools and university has varied greatly.

Monitoring of project activities was initially dedicated to lower secondary schools and resulted in a mid-term report (IRVAPP 2012). For this reason, the following analysis concentrates on this specific school level.

The Scuol@ 2.0 programme started in 2011 and unlike Cl@sse 2.0 involves entire schools rather than single classes. The declared objective is to support innovation in aspects of traditional schooling, particularly to inject flexibility into the management of curricula, timetabling, and human and technological resources.

In the 2012–2013 school year, 14 schools entered this programme. An additional 15 are expected to enter during next school year (2013–2014). Each selected school receives a contribution of EUR 250,000 from the Ministry of Education to invest in equipment. To monitor and evaluate the second round of this initiative (2013–2014), the Ministry has nominated a national scientific advisory group that has also examined the Cl@sse 2.0 mid-term results and first outcomes of Scuol@ 2.0.

1.3 Analysis

This section reflects on some key aspects the Cl@sse 2.0 and Scuol@ 2.0 initiatives. It looks in particular at two issues that are crucial for understanding how and under what conditions ICT can become a catalyst of innovation in schools: the enhancement of the learning environment and the trigger of innovation. The analysis is mainly based on the following documents and materials: the first mid-term report on Cl@sse 2.0 (IRVAPP 2012); the documentation of the Italian Plan for Digital schools (MIUR 2012); the first documents produced by the scientific advisory group established by the Ministry of Education (to which the author of this paper belongs); Eurypedia, the European Encyclopedia on National Educational systems (Eurypedia 2012); the review of the Italian strategy for digital schools performed by the OECD (Avvisati et Al. 2013).

1.3.1 Cl@sse 2.0 and Enhancement of the Learning Environment

The Cl@sse 2.0 programme has been carried out in many different ways by the different schools, something which accords with the autonomy they are afforded. For this reason, it is useful to analyse the mid-term evaluation data to understand how the schools in different contexts have faced the challenge of enhancing learning environments with ICT. Two issues are worth noting: (a) in Italy the class is a meaningful organizational unit in which students remain more or less the same over the entire school cycle; (b) the learning environment concept is intended in a broad sense here: it encompasses not only the tools used, but also the organization of teaching and learning activities, their goals, the way ICT is embedded in pedagogy, the physical setting, the roles played by the different actors, the assessment performed and so on. In this paper, analysis of how ICT integration has affected classes 2.0 learning environments is carried out at single class level and at the level of the Cl@sse 2.0 programme's global implementation. Figure 1.1 outlines these levels of analysis and the related issues.

Single class analysis considers the stated goals and objectives of the projects presented for selection of the classes 2.0, the impact of ICT integration on class organization and on teaching and learning activities, and the mid-term results obtained (according to a number of indicators). Analysis of the programme Cl@sse 2.0 as a whole focusses on global monitoring of the initiative and infers its main strengths and weaknesses.

Tables 1.2 and 1.3 briefly summarize the main findings from the two-level analysis of the mid-term report (IRVAPP 2012) and the data and considerations that emerged from the advisory board meetings that the author attended. The issues of concern derived from this analysis are briefly summarized as well. Table 1.2 refers

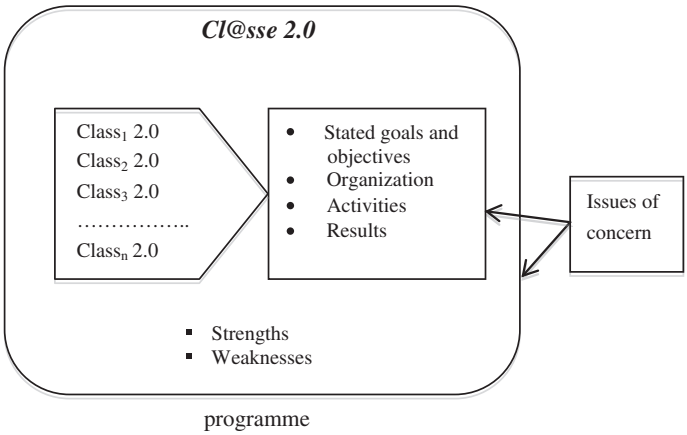

Fig. 1.1 Levels and issues of analysis of the Cl@sse 2.0 programme

Table 1.2 Analysis of Cl@sse 2.0 outcomes at single class level

Cl@sse 2.0	Main findings (classes)	Issues of concern
Stated goals & objectives of submitted projects	The great majority of projects aim to: Develop students' transversal skills and collaborative learning Personalize learning Innovate teaching methods Enhance teachers' digital skills	Teachers need to develop a more widely shared understanding of what is meant by 'transversal skills'
Impact on class organization	Daily ICT use in class rises from 54.4 % (initial data) to 70 % (mid-term report): 23.1 % over 3 h. a day; 38.9 % up to 3 h. a day; 8 % 1 h a day The vast majority of teachers acknowledge the need to change the physical setting of the class	Teachers generally fail to provide details about the kind of activities carried out with ICT and the way they have been carried out
Impact on teaching and learning activities	Almost all teachers state they use Office applications, internet browsers and/or blogs Little interest is expressed in the use of educational software or discipline specific software (under 10 %) 44 % of teachers state they use learning objects to build learning activities Many teachers express an orientation towards using ICT for student assessment	Often the software tools used don't match up with the objectives stated in the project plan Stated learning objectives are often described in quite general terms (e.g. pedagogy innovation, enhancing learning outcomes) with no specific targeted goal
Teachers' perceived results	Enhanced digital skills of teachers (25 % greatly, 75 % moderately) and students (66.7 greatly, 27.8 moderately) Development of students' transversal skills (12.5 greatly, 87.5 moderately) Increase in peer collaborative work (23.8 greatly, 66.7 moderately) Increased student engagement in learning activities (54.1 greatly, 36.1 moderately) Increased student motivation (almost 100 %) No significant increase in students' learning performance (for 43 %) Greater collaboration with families and local institutions Interaction with supporting universities is considered useless (55.5 %)	The relationship between student motivation and performance needs further investigation and adoption of appropriate indicators The way teachers' perceived results are gathered in the mid-term report needs to be reconsidered and tuned The modalities and objectives of external support for schools (from the universities selected by the Ministry) needs to be reconsidered

to the single classes 2.0 while Table 1.3 outlines the main strengths and weaknesses of the programme as a whole.

It is worth noting that the mid-term report took into consideration a variety of qualitative and quantitative data: projects submitted for selection; student

Table 1.3 analysis of Cl@sse 2.0 outcomes at overall initiative level

	Strengths	Weaknesses	Issues of concern
Cl@sse 2.0 initiative	Some classes 2.0 have become school bridgeheads for the local community Classes 2.0 have stimulated collaboration between school, families and local institutions An increase in both teacher and student motivation has been widely reported An increase in collaboration among teachers in the same school (not only the same class) has been reported	Teachers' limited digital competency is reported as a brake on the initiative Some negative impact of ICT use on students' learning is pointed out by teachers: e.g. distraction from disciplinary content learning, content simplification, greater focus on technology than on subject contents, low quality and general inappropriateness of available digital content, perception of ICT-based activities as dispersive, etc Teachers remark a slowdown of teaching pace The use of some tools, like interactive whiteboard, even if element of aggregation can have also a negative impact on class dynamics in terms of distraction, messy interactions, etc.) General obstacles to the initiative have been: the heavy burden of bureaucratic requests made to teachers, the delay in the acquisition of the equipment, the temporary status of many teachers, few support offered to schools by universities involved	The relationship with the universities chosen by the Ministry for local support was generally perceived as a negative imposition unrelated to daily class work It is not make clear what method was used by the Ministry to select and to analyse the qualitative tools used to monitor the initiative (e.g. class logbooks, teacher questionnaires, etc.) and how the generated data can be compared Over time there has been a reduction in the number of class logbooks filled in. In general, teachers perceived the documentation demands to be excessive

assessments (test scores compared to control classes from the same school); logbooks kept by participating teachers; teachers' self-assessment questionnaires; and reports from supporting universities and national agencies. By infusing technology into class activities, students' and teachers' ICT familiarity and competences seem to increase. However, even though ICT use has positive results on motivation, the impact on subject teaching and learning activities seems limited.

Analysis of the mid-term report suggests that a more in-depth investigation of the way teachers perceive the role of ICT for teaching disciplinary contents would be useful for future orientation and for teacher training, also because in some cases teachers perceived the use of ICT on subject learning as negative (see Table 1.3). In the

vast majority of cases, the main goal stated for using ICT in class is the development of transversal skills, even if there is no general shared understanding about what these skills are and how they can be evaluated; ideas on this appear quite generic and do not correspond to specific activities. Closer examination of the correspondence between stated objectives and the type of software and digital resources actually used in class seems to be necessary. Moreover, even though 44 % of teachers state they use learning objects, no further indications are provided about the type, characteristics or content of these materials, or about their origin (e.g. who has developed them).

Other critical aspects for further investigation are the relationship between ICT use and students' learning performance, and how and to what extent assessment methods have changed. It is interesting to note that when teachers refer to the use of technology for learning assessment, they mainly intend the use of e-mail to submit evaluation tests or the evaluation of multimedia contents produced by students.

ICT integration seems to have induced some change in the organization and physical settings of classes, but for effective innovation to be achieved this aspect needs to be reconsidered in a wider perspective: change in whole school organization, curriculum and timetabling, time constraints, modality and content of student assessment, etc. The fact that teachers reported some negative effects of ICT integration, like the perception of ICT-based activities as dispersive or the slowdown in teaching pace induced by ICT use, could indicate that in many cases ICT integration only leads to surface changes that have little real impact on teaching and learning activities, and can often have negative perceived effects on pedagogical activity.

One critical aspect of the monitoring of Cl@sse 2.0 initiative (see Table 1.3) is the way in which perceived outputs were gathered and evaluated. It would be useful to reduce the number of indicators considered and to focus on a limited set of specific issues; this would lead to generation of more homogeneous and focused data, and also lighten the documentation load imposed on teachers.

Although having a class in the initiative had positive effects for individual schools, like increased teacher collaboration and strengthening of family-school ties, the effects were limited. The results obtained in terms of innovation in teaching and learning processes are minor and, in general, the initiative does not seem to have the critical mass needed to induce widespread innovation; too few schools in the country have been involved (416), teachers' professional development is insufficient and not enough digital resources are available.

These considerations suggest that, in order to create an effective innovation trigger via a 'contagion' strategy, it would be more appropriate to engage entire schools rather than individual classes. For this reason, it is worth considering the School@ 2.0 initiative and briefly analyzing the way it has been implemented.

1.3.2 Scuol@2.0 and the Innovation Trigger

Among the main objectives of the Scuol@ 2.0 programme is to establish a limited number of controlled cases to test and analyze how the introduction of advanced technologies can change teaching and learning processes and the entire work

organization in schools. The idea is to identify approaches and methodologies for effective innovation that can be mainstreamed through the system.

As mentioned earlier, 14 schools entered this programme in the 2012–2013 school year. No official report on initial results has been released yet. Considering the early qualitative data discussed during advisory board meetings, the impression is that the criteria adopted for selecting these schools were not entirely appropriate and they were not applied in a uniform manner in the different regions. Thus, the initial outputs vary widely from school to school, making it difficult to identify general trends, also because of the limited number of schools involved. Accordingly, the advisory board adopted more specific, uniform criteria for selecting the 2013–2014 uptake of 15 additional schools and for monitoring the initiative as a whole; these are outlined in Table 1.4. Analysis of these criteria can provide a clearer idea of the conditions considered necessary for ICT to become a trigger of innovation at school level.

Critical selection criteria that test-bed schools needed to meet are the possession of appropriate ICT infrastructure, teaching staff with adequate ICT skills, and limited teacher turnover. Links with outside organizations (universities or research centres, companies, etc.) are considered an advantage, as is the role of the school as reference for the local community (e.g. links with other schools and/or local institutions for training or consulting activities). Applicant schools had to document their experience in the field and to submit projects that feature concrete ideas about learning activities involving medium and long-term use of ICT, new organization and pedagogical practices, and modes of cooperation among teachers.

In evaluating proposals and monitoring results, the stress is on changes not only in technology use, but also in more flexible management of curricula, timetables, and human and technological resources. These factors are expected to help overcome boundaries between classes and between formal and informal learning (inside and outside school). To this end, the Ministry has exempted the participating schools from a number of national guidelines and constraints.

The first general consideration to be made about the future of the Scuol@ 2.0 programme is that, to achieve its ambitious objectives, it requires a higher level of investment so a larger number of schools can be involved and adequately supported. This latter aspect is considered an essential and critical component of the programme. Schools must be supported in changing their teaching organization that means to reconsider the teacher's role in the classroom, the use of software and digital contents, the adoption of distance learning modalities for homework assignments, the adoption of innovative, cooperative learning models and assessment strategies.

This support needs to be centrally coordinated, not left to single entities such as local universities, as was the case with Cl@sse 2.0. In addition, support should not be seen as a top-down intervention, but as a dynamic process built and rebuilt together with all school actors, starting from their daily needs.

Table 1.4 Selection criteria for schools participating in the second round of Scuol@ 2.0 program

Issues considered in the Scuol@ 2.0 application form	Issues	Evaluation criteria
School features (state of the art)	General: n° of classes; % of teachers turn-over; n° of teachers trained in the use of ICT; etc Available technological infrastructure: internet, intranet, Wi-Fi, platforms, school website, etc Teachers' professional development: training initiatives and/or in-field experimentations promoted by the school in the use of ICT for teaching and learning processes Links with the local community: university, research or training centres, companies; participation in inter/national projects involving the use of ICT; offered services	Broadband Low % of teacher turn-over Relevant number of trained teachers Good extra-school links Established collaborations with university or research centres Involvement and results obtained in previous projects Services offered to the local community (e.g. training, skill centres, etc.)
Project features	Description of the proposed project and of the way in which ICT integration will be performed (approach, scaling, etc.) Reorganization of school's physical environments and timetable Pedagogical and methodological innovation Curricular changes Digital resources New evaluation and assessment modes Ties with families New initiatives for teacher training	Scientific and organization quality of the project Indication of concrete learning activities involving medium and long-term use of ICT Structural and pedagogical changes (e.g. how class f2f lessons will be transformed, how ICT will be used for communication with students and families, etc.) How learning will be personalized Modalities of cooperative work among teachers Curricula innovations Integration of digital resources in the teaching of disciplinary contents Development of digital learning resources Methods and tools for formative evaluation Methods for student assessments Foreseen teachers' training activities

1.4 Discussion

Italian schools have in general a low ITC penetration, that is, Italy is not well positioned as far as ICT equipment in schools if compared with other European countries as reported in the 'Survey of Schools: ICT in Education' promoted by the European Commission to benchmark countries' performance in terms of access, use and attitudes to ICT (European Schoolnet 2013). For example, in 2011–2012, the average number of available computers per 100 students (4th grade) was six compared to an average of 14.5 in EU countries. In most countries, the older the students are, the more the computers will be, and this trend is also present in Italy. At grade 8, Italy is ranked among the bottom group of countries with 8.3 computers per 100 students (EU average: 21.1) as shown in more details in Fig. 1.2. Moreover, at grade 4, 80 % of Italy's students are in schools with only basic digital equipment, slow or no broadband, and only limited connectedness (EU average: 48 %). Only 6 % of Italy's students attend schools with advanced digital equipment against 37 % of EU average.

Given this situation, the National Plan for Digital Schools launched by Italian Ministry of Education is an important step towards mainstreaming ICT use in Italy's classrooms and realising its potential as a catalyst for educational innovation.

The adopted strategy has been to target schools and teachers eager and ready to initiate change, to stress pedagogic uses of technology rather than merely equipment, to phase in reform, and to conduct experiments. This seems an appropriate way to trigger wide-scale change. However, the overall level of investment is too small (around 0.1 % of the budget for schools), and this has limited the

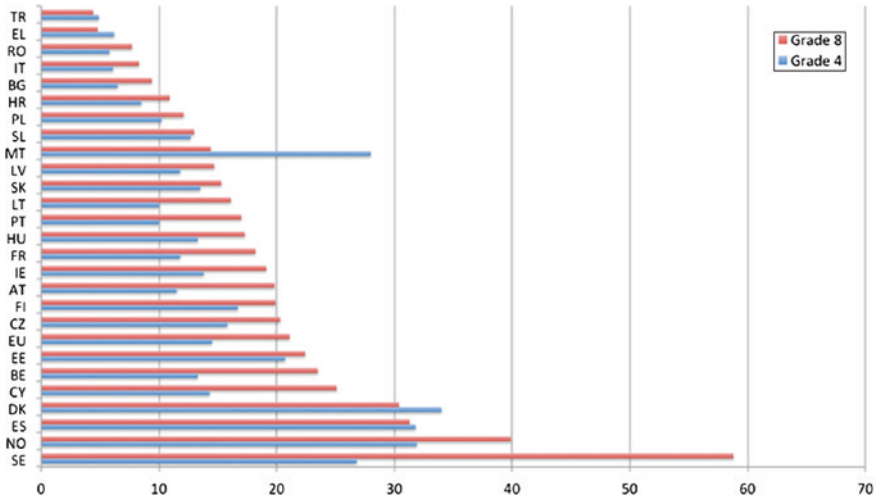

Fig. 1.2 Number of computers per 100 students (school grades 4th and 8th) in European countries (European Schoolnet 2013)

effectiveness of the Plan's various initiatives. The need to raise funding is also acknowledged in the review of the plan carried out by the OECD (Avvisati et al. 2013), which states: 'in its current design, a significant rise in the plan's budget through public or private sources is a necessary condition for its success' (p. 9).

Since a significant budget increase is unlikely in the current economic climate, the OECD suggests concentrating resources on the Scuol@ 2.0 initiative, which focuses on new models of schooling. The school-wide approach of this initiative seems to have greater potential for educational innovation, hopefully leading to the adoption and testing of new teaching practices, new models of school organization, new products and tools to support quality teaching. As highlighted in the previous section, meeting these goals means first of all carefully selecting test-bed schools and supporting them not only in tuning the design, but also in the daily implementation of the project.

Adopting the entire school as the relevant unit of analysis makes it possible to consider issues that cannot be addressed at single class level, for example alignment of ICT integration with other system elements like curricular and assessment changes. Moreover, when teachers use ICT in all their classes they can gain more experience and context-specific knowledge. Since all the school teachers are involved in the project, peer learning is more likely to happen, and the sharing of ideas, resources and methodologies (also at subject level) is more fruitful.

Even if the phased approach and the bottom-up strategy adopted by the Plan seems appropriate in the current situation, results obtained at school level can be better leveraged if test-bed schools are seen not as single units but as a network. For example, the OECD report suggests that the Plan should 'concentrate resources on the Scuol@ 2.0 initiative, redesign it around local school networks and discontinue the Cl@sse 2.0 initiative' (p. 41).

Networks of schools can help to optimize resources. For example, key aspects like teachers' professional development or ICT-based communication platforms supporting schoolwork can be shared. In addition, greater critical mass is helpful for attracting further funding from local institutions or private foundations. When connected in a network, test-bed schools can provide mutual support for piloting new pedagogic and organizational practices and are better placed to foster mainstreaming of ICT in their local area. This would help to spread the benefits of the Plan beyond a limited number of early adopters, providing sufficient investment and support is on hand.

The idea of supporting networks of innovative schools in Italy is not a completely new indication; it has been tested in pilot cases outside the National Plan for Digital Schools, often with interesting results. For example, the Ministry of Education has supported an innovative project called Wikischool (Benigno et al. 2013), which establishes a network comprising the three lower-secondary schools in Italy that have special experimental status and which were previously funded separately. The project aims to instil research and reflection in teachers' daily work, promote cooperation and foster systematic use of ICT in all spheres of teachers' professional practice. The Institute for Educational Technology (ITD-CNR), of which the author of this paper is the director, has collaborated with

the Wikischool network from the beginning, supporting it in the development and management of the schools' ICT infrastructure and in the design of innovative pedagogical activities. Moreover, cooperation has been established between the teachers and ITD-CNR researchers for monitoring and critical analysis of the initiative.

This experience and its positive outcomes have highlighted the importance of establishing closer dialogue between educational research and Education Ministry initiatives in order to provide policy makers with useful evidence and informed documentation obtained from inside the process. Pilot schools require support and monitoring while developing and implementing innovative resources and practices. In addition, documented reflection on critical issues and difficulties encountered needs to emerge from direct interaction and cooperation with the teachers involved. If this partnership is fruitful, it can create the conditions for peer learning, system learning and pedagogic transformation, as recommended by the OECD.

One of the main problems with the initiatives implemented in Italy's Plan for Digital Schools, particularly with the Cl@sse 2.0 and Scuol@ 2.0 initiatives discussed in this paper, is that results achieved locally are rarely scaled up at system level. Even when good practices and successful solutions emerge, they remain largely confined to the context in which they were generated, making it difficult to capitalize on outputs at the general level. Thus, a more coordinated and reflective approach is necessary to assure the success of the Plan.

Of course, the long-term success of the Plan strongly depends on other issues as well, such as teacher training opportunities and the availability of a sufficient quantity of high-quality digital learning resources. These aspects (which fall outside the scope of this paper) have been addressed in other initiatives put in place by the Ministry within the Plan; however, greater coordination and more widespread actions are called for.

1.5 Conclusions

ICT resources are critically important for education, both because their use can improve teaching and learning processes and because they offer an opportunity for innovation in contents, methods and pedagogy. Nevertheless, the integration of technologies in schools has to be approached in a critical and informed manner, taking into account the complexity of the underlying processes. Successful integration of ICT into schools calls for understanding of the opportunities technology offers and of the needs emerging from the context of application. Unless innovation is truly embraced, technology is unlikely to become an integral part of the education system, but outside the prospect of effective teaching and learning improvements, the use of technology will not last over time.

School improvement and system-wide pedagogic innovation is a cumulative and collective endeavour. In recent years, scaling up results from small pilots (often single classes) to statistically significant numbers has become a

pressing issue. For example, large-scale European research projects in Technology Enhanced Learning, such as 7thFP—IP (Integrated Projects), have been required to ensure large-scale piloting involving up to 1,000 classrooms. This strategy certainly increases experimental coverage and data, but largely overlooks the system level since it does not involve schools in their entirety. As this paper has pointed out, the school seems to represent an appropriate unit of analysis for studying the successes and failures of ICT integration. Ideally, test-bed schools should be clustered in networks to increase local opportunities for learning, foster sharing across schools and establish broad communities of practice (Avvisati et al. 2013).

Moreover, in a policy of innovation, documenting successes and failures is key for system learning. For this reason, it is important to strengthen dialogue between academic research and education systems in order to set up monitoring activities and to support teachers' reflection and learning from the work accomplished (Olimpo et al. 2010).

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Chapter 2
Inclusive Education in Rural Alberta, Canada: Utilizing ICT to Support Twenty-First Century Learning

Dermod Craig Madden

Abstract Information and Communications Technology (ICT), has become a term with many meanings within many contexts. For the purposes of this paper, ICT in a K-12 context represents the possibility for change in the public education system in Alberta, from traditional pedagogies of exclusion to one which embraces inclusive practice for all students. The implication of such fundamental change has equal significance for teacher practice. The use of ICT has the potential to transform traditional education into multidimensional learning environments that support traditional, mobile, and blended learning environments. In so doing, the significance of ICT for twenty-first century learners may be tantamount to a paradigm shift, which could change the face of public education, and have a significant positive impact on teaching practice and student learning.

2.1 Introduction

Information and communications technology, (ICT) is an often used term to describe a system of unified or connected communications systems. In K-12 education in Canada, and more specifically in Alberta, the term ICT denotes both a process and a product. Since the 1980's, ICT and the extent to which it has been a part of the public education system, has been measured more by the number of devices in the school than the actual utility for said innovations. In 2013, the debate continues, much of which centers around the significance of inclusive education on the public education system. The industrial-age or factory model of education has been obsolete for some time, and as a new paradigm of education is evolving throughout the world a commitment to pedagogically sound change needs to be articulated.

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R. Huang et al. (eds.), *ICT in Education in Global Context*,
Lecture Notes in Educational Technology, DOI: 10.1007/978-3-662-43927-2_2

Inclusive teaching practice stipulates that students learn in different ways and at different rates. Traditional industrial age pedagogies require all students to learn a concept at the same rate and at the same time. Inclusion supports the practice of holding levels of achievement constant, while allowing time to vary, thereby providing the individual with the necessary time to achieve the outcome and attain the standard, with each student to learning at their own pace.

Two universal themes have emerged in recent years which, if given serious consideration by governments and educational institutions, may provide the necessary contexts for legitimate mobile learning practices. UNESCO is examining the value of mobile technologies in creating universal educational access, equity and quality; and, the extent to which these technologies can support the fundamental changes to instructional design and teaching practice, to meet the needs of today's learners (West 2012). It is with these two considerations in mind that ICT will be reviewed from the perspective of Aspen View Public School Division No. 78, a small rural school division in the province of Alberta, Canada.

Aspen View Public School Division No. 78 is committed to a process, which:

- Accommodates the needs of twenty-first-century new millennium learners
- Embraces the implementation of technology
- Considers initiatives that support differentiated instruction, inclusive practice, and assessment for learning.

2.1.1 Instructional Practice

Central to an inclusive perspective, which acknowledges the ever increasing significance of ICT in K-12 education, is a commitment to a pedagogy that supports the premise of twenty-first century learning. Such pedagogy is constructivism. Constructivism has been cited as, theory of learning, philosophy of learning, component of instructional design, instructional strategy, style of instructional strategy, and learning environment. There are constructivist-based courses, constructivist discussion models, constructivist pedagogy, constructivist-based online courses, the constructivist type of online learning, constructivist instructional principles, and a constructivist framework, just to name a few.

Constructivism as learning theory is not a recent development. Much of what is deemed as constructivist theory today has evolved from several sources over considerable time. The fundamental principles of constructivism have always been present in some capacity in those educators who understood the importance of active engagement and social interaction.

Knowledge is not passively received either through the senses or by way of communication, but it is actively built up by the cognizing subject. The function of cognition is adaptive and serves the subjects organization of the experiential world, not the discovery of an objective ontological reality (Confrey 2011).

Constructivist learning theory has its roots in the works of Dewey (1929, 1938), Piaget (1952), Vygotsky (1978), Bruner (1966), Von Glaserfeld (1989),

Palincsar (1998). Constructivism emphasizes the significance of constructive knowledge on the individual's active and reflective thinking process. Piaget's interests focused more on the impact of constructivism on the individual learner, whereas Vygotsky stressed the importance of social interaction and social systems on individual learning. Dewey believed that learning was dependent on the social environment in which the learner is placed. He also believed in the importance of real learning in context through active engagement within a community of learners.

A constructivist learning environment is one that promotes active student engagement in the learning through discussion, debate, and the use of cooperative learning strategies, to solve problems, to learn from mistakes, and to experience the social contextualized nature of learning through situated, authentic learning (Palincsar 1998). Constructivism is not new, but it is controversial in that it challenges long standing pedagogical practices and brings into question the educational value of standardized testing and the practice of assessing content mastery. Social constructivist learning theory postulates that to meet the needs of new millennium learners, the learning process should be collaborative and social. The learning should be interactive, such that the learner is actively engaged to the point of being self-directed. In this context, the concept of "community of learners" replaces the traditional "learner in isolation".

Constructivism is a philosophy of learning founded on the belief that through our individual life experiences we create a personal understanding of our world. Each individual establishes rules and protocols to rationalize their experiences and their place in this world. Learning then becomes a process of making adjustments to accommodate new experiences. Constructivist theorists claim that learners interpret information and the world according to their personal reality and that they learn by observation, processing, and interpretation; and then transform the information into personal knowledge.

Constructivist learning theory has had a significant impact on instructional practice in K-12, post-secondary education, and in the corporate world. This is in part due to the advent of innovative learning approaches that, almost without exception, are rooted in constructivist theory. Examples of this include problem-based learning, action learning, situated learning, experiential learning, and collaborative learning. Common constructivist characteristics of these models include, "… designing authentic learning activities that are complex, realistic, and relevant; promoting social negotiation as an integral learning activity; supporting multiple perspectives and multiple modes of content representation; and encouraging ownership in the learning process" (Dabbagh and Bannan-Ritland 2005; Driscoll 2000).

2.2 Instructional Design: Inclusive Practice

Innovation and change have been the norm in public education in Alberta in recent years, and it appears that this will be the case for the foreseeable future. Aspen View has embraced this point of view. Advances in technology have laid the foundation for a new

digital world, and established a context for the rebirth of critical reflection and debate about the nature of learning and the role of the teacher. To transform traditional teaching practice from that of the teacher directed, content-driven, one-size-fits-all model of instruction, to one that acknowledges the significance of the student and the need for practices that promotes self-directed, independent, ubiquitous learning; requires a paradigm shift in how we perceive public education in Alberta. Aspen view has initiated a number of pilots and partnerships to facilitate these changes. We promote the use of ICT, and a move away from traditional classroom settings, for less obtrusive, virtual, and mobile learning environments; which challenge the flexibility and adaptability of teachers and their ability to keep abreast of changes in instructional design; and the need for learning environments that support inclusive practice. To this end we have initiated several pilot projects and partnerships that we believe will become best practices for those involved and promising practices for others within our system.

In Aspen View, we are aware of the reluctance of teacher education programs to change, and the consequent reluctance of teachers in the field to accommodate change within the public education system. Rather than mandating system-wide change, we have identified change agents within our system and allowed them to lead. There is a significant body of research that identifies the importance of teacher attitudes and beliefs as an underlying construct of inclusive education, and the impact that those attitudes and beliefs have on educational outcomes for all students. According to the research, the key elements in the successful implementation of inclusive policy are the attitudes, values, and beliefs of teachers, who have the major responsibility for implementing them (Ainscow and Sandhill 2010; Avramidis and Norwich 2002; Cullen et al. 2010; Van Laarhoven et al. 2007). "Successful inclusion requires persistence and innovation to sustain the effort, and to develop approaches to meet the new challenges that emerge over time" (Porter 2008, p. 64).

Alberta has a well established reputation as a global innovator in education and as a world leader in educational reform. Albertans have had the good fortune of living in a province rich in natural resources, where investment in education has been a priority. Education and technology has been a very important component of this investment. Unlike students in the developing world, Alberta students have had access to computer technology since the early 1980s, albeit, mostly in the form of standalone computer labs used primarily as word processors, with limited access to the internet. Since that time, despite the significant changes in technology, very little change has occurred in pedagogy and instructional design at the classroom level to incorporate the new technology. Part of the issue is that technology was initially introduced without a clear understanding of its utility or its potential. For a time it seemed that just having the technology was sufficient. The norm was to utilize the technology to accommodate existing teacher practice and pedagogical beliefs. Changes to pedagogy were minimal.

Ubiquitous social networking is a reality. Social networking practices are providing opportunities for educators to engage students in inclusive learning environments, wherein the design of the learning environment mandates a degree of student autonomy, that is usually absent in traditional classroom settings. Mobile learning environments, under the guidance of the right teacher, have the potential to foster the

necessary degree of "distance" required by students to ensure the six dimensions of freedom associated with twenty-first century learning; access, content, media, pace, space, and time (Paulsen 1993). The flexibility of ubiquitous engagement has implications for education in Alberta, for the K-12 system and the post-secondary system. By implication, the interconnected nature of both systems and the importance of student bridging and transitioning, establishes the need for partnerships and collective educational planning processes that encompass the life of the learner.

There is a broad range of research and investigative studies on the scholarship of ICT and blended learning environments. Global access to mobile technology is increasing daily, due to the advantages of size, portability, cost, and universal ease-of-use. This, in conjunction with the ever-changing advanced features of mobile technology, is creating a context for ubiquitous global learning. The use of ICT in mobile and blended learning environments has the potential to accommodate the needs of twenty-first century learning while supporting pedagogically sound practices. Community instructional resources and activities can be brought into the classroom; and the portability of ICT allows the classroom to move outside the school walls, facilitating more meaningful learning.

An inclusive philosophy among governments and educators focuses on welcoming and supporting the diversity of all children in a given community, within a socially just education system (Ainscow and Sandhill 2010). There is a growing consensus among educators that the use of ICT in education has the potential to enhance instruction that takes place within the traditional classroom, as well as to support experiential field learning experiences, and distance education systems; by allowing for immediate, enhanced access to resources and learning supports previously not available to students (Anderson 2006; Belawati 2005; Chun and Tsui 2010; Stead 2006). The use of this technology may also promote inclusive practices, providing equitable access to educational supports and services for students regardless of ability, ethnicity, gender, religion, and location.

At present, given the limited amount of quantitative and qualitative research available on the use of ICT in education, using mobile technology in blended learning environments within K-12 public education systems, there is a need for ongoing research that incorporates an inclusive perspective. Such a perspective would highlight the importance of self-direction in learners, and the need to move away from teacher-directed, content-focused approaches to teaching and learning. Student-directed approaches encourage independence, reflection, and understanding, and the ability to apply this understanding in a real life context, in collaboration with peers; rather than teacher-directed approaches which focus on memorization of content for the purposes of summative evaluation. Distance technologies have created contexts for such learning, which in a blended context may have significance for K-12 systems.

2.3 The Importance of Partnerships

Aspen View is currently involved in a number of ICT initiatives and partnerships with other school districts, post-secondary institutions, and corporate entities, all of which are designed to promote twenty-first century learning within an inclusive

framework. The following is a synopsis of some of these collaborations and partnerships designed to promote twenty-first-century new millennium learning:

- Aspen View and Portage College: online EA certification program in Inclusive education and Rehab services; online apprenticeship courses in Culinary Arts, Welding, Carpentry.
- Aspen View, cross-ministry group and the University of Calgary: online graduate level program in Inclusive Leadership.
- Aspen View, Athabasca University, Beijing Normal University: Using ICT to establish and maintain partnerships between students at Landing Trail Intermediate School in Athabasca, and students at Heping li No. 9 Primary School, Beijing, China.
- Aspen View, Athabasca University, and Xerox Canada: Grade nine students from Edwin Parr Composite and Outreach students at Vilna School use android tablets within a secured virtual space that functions as a virtual classroom, incorporating the use of Moodle and Adobe Connect. Student progress is tracked using an online Learning Management System (LMS), and a semantic/syntactic parsing tool (ongoing formative assessment for learning), which tracks individual student development. Students assume anthropomorphic pedagogic agent (a.p.a.) personas and function within an online virtual learning environment.
- Aspen View, Blue Quills College: Students and staff in Vilna school: collaborate in real time and in virtual space to study, celebrate and promote aboriginal history and culture.
- Aspen View, University of Lethbridge, Concordia University: Abracadabra, the online early literacy program for preschoolers.
- Alberta Provincial Dual Credit Initiative: Aspen View, Athabasca University, Xerox Canada, Alberta Education, College of Alberta School Superintendents: 'Twenty-First Century Learning: An Introduction to Information Systems, Computer Applications and online Learning COMP 210; COMP 214. Second Year University courses are offered online to Aspen View high school students through Athabasca University, for dual credit.

In addition, there are a dozen ICT initiatives involving 250 android tablets, ongoing within the school system involving every age group, and cross-ministry service providers. Aspen View continues to pursue partnerships that promote constructivist pedagogy, sound instructional design and twenty-first century learning practices.

2.4 Embracing Change

Within the parameters of an inclusive educational system there is the need for two developments to occur in public education to ensure a shift away from the current standardized time-based paradigm of education. The first is the need to advance learner centered psychological principles and methods of instruction. The

second is the development and application of advanced technologies (ICT), which are embedded within the curriculum and within teacher practice (Reigeluth and Carr-Chellman 2009). The challenge to educators is to proceed with caution, but proceed nonetheless to help schools, teachers, students, and parents as we transform public education from the noninclusive standardized model founded in the Industrial Revolution, to a learner centered information age paradigm of education. Technology itself is not the answer, but ICT can support a broad range of instructional design theories that facilitate learner centered instruction, such as problem-based learning (Downing et al. 2008), self-directed independent learning (Broad 2006); and individualized learning (Race 2002).

Reluctance to change is systemic in public education and has its roots in traditional teacher education programs at the post-secondary level. In addition to the need for change in our teacher preparation and education programs, K-12 school systems need to consider their role in embracing change by ensuring that the skill-sets of their teachers are of the highest quality. This can only be done through a focus on lifelong learning and professional development.

2.5 Outcomes-Based Assessment Practices

As technological changes advance and ICT becomes synonymous with learner centered education, constructivist teaching, blended learning environments, mobile learning, and ubiquitous learning, the need for technology in education will be obvious. The one way to ensure that there is utility for ICT is to articulate learner outcomes within the K-12 curriculums in all subject areas and at all grade levels. These outcomes should also correlate with both formative and summative assessment processes, at least up to and including grade nine. This is the case in Alberta. Using the Alberta model one can see a structure that supports twenty-first century learning, inclusive education, outcomes-based assessment and outcomes that require active student and teacher engagement within the core curriculum. When such a foundation is in place, which delineates ICT outcomes for all students, and does so within an inclusive framework, the chances that students will incorporate ICT within their work are significantly enhanced. In the case of Alberta, the outcomes are classified under three distinct headings, which are the same for every grade. They are as follows:

- Communicating, inquiring, decision-making, and problem-solving
- Foundational operations, knowledge, and concepts
- Processes for productivity.

Within each of the three areas there are a series of "students will", action statements, each of which consists of a number of suggested activities to achieve the outcomes through the use of ICT, both in and out of the classroom, in traditional, blended, virtual, and concrete learning environments. Although only in its infancy stage, the approach is significant in that it acknowledges the importance of

technology in education, and by default the need for change in teacher training as well as traditional teaching and assessment practices. Notwithstanding the importance of embedded ICT learner outcomes in kindergarten through grade twelve, there is the possibility that such outcomes may also remain ignored by teachers who are not comfortable with technology.

Assessment, evaluation, and communication of student achievement and growth are essential parts of the teaching and learning process. This is also the case when assessing the ICT outcomes in grades K through 12. To ensure that the process is inclusive, the following four principles are in place for every student that every grade:

1. Assessment practices should be carried out in such a way that they support and enhance ongoing student learning and development; as such assessment should be continuous.
2. Students benefit when they are involved in the assessment process; as such assessment should be collaborative.
3. Assessment practices should address learner outcomes and include a variety of strategies that meet the diverse learning needs of students; as such assessment should be comprehensive.
4. Assessment practices should identify and clearly define the critical aspects of performance for demonstrating student learning; as such assessment should include criteria (Alberta Education 2007).

Research shows that this type of assessments (rubrics), in which students are engaged in content that is articulated through the use of ICT, accommodates metacognition that is both reflective and flexible. Opportunities to engage in a process of reflective thinking, which affords students the opportunity to engage in a well-constructed dialog, may be conducive to a process of knowledge construction, or constructionism (Rovai et al. 2008).

Those educators who continue to dismiss the significance of ICT by association are also dismissing the significance of those skills deemed as twenty-first century learning skills, of which systemic or systems thinking skills has been identified by many as crucial (Luterbach and Brown 2011).

2.6 ICT Outcomes

Educational leaders are beginning to realize that digital learning is no longer a possibility, but rather a necessity. There will always be a place for the lecture in the classroom, but such teacher-directed engagement processes tend to engage only the teacher. Often the concept without context remains unlearned. Technology has the ability to enable and engage the student in relevant student centered personalized learning activities. Incorporating common core standards, which focus on analytical thinking, almost certainly requires a move away from teacher dominated instructional practices to learning environments that are

more student-centered and conducive to the development of analytical thinking skills. Such learning environments, which incorporate traditional classroom and online learning or e-learning practices, are often referred to as blended learning environments.

Within the Alberta framework for ICT outcomes in K-12, those skill sets deemed as essential for twenty-first-century learners are: communication, collaboration, critical thinking, personalization, and knowledge creation. As such, the significance of ICT on the learning process is tantamount to a paradigm shift, away from the traditional process of absorbing content, for the purposes of summative, evaluative accountability of the system; to that of learning how to learn new concepts in new ways, and acquiring new skills that facilitate scaffolding and transitioning beyond the immediate classroom. More and more the rhetoric of pedagogy and instruction focuses on processes, which are not conducive to traditional classrooms, but rather support student-centered learning approaches, which promote the use of ICT, such as student centered learning, personalized learning, constructivism, inquiry-based learning, project/problem-based learning, collaborative learning, and flipped classrooms (Alberta Education 2002).

Educators who still believe that they do not need ICT to do their job, or those teacher training programs that have shied away from inclusive practice and constructivist pedagogy, the die has been cast. ICT will soon be the driving force behind inclusion, constructivism, and meaningful student engagement. Systems are already moving beyond simply integrating technology, and in many places students and staff are utilizing ICT to realize their goals. As utility for technology continues to grow, there will come a time when student and teacher goals can only be realized through the use of ICT.

With ICT outcomes embedded within the core curriculum, technology may provide solutions to many of the ongoing problems faced by public education systems around the world. The most obvious advantage of access to ICT is the immediacy of access to information that it provides; which should foster a mindset that is conducive to lifelong learning opportunities. Digital curriculum and digital content will soon be available on a global scale, as well as convenience and security of digital testing. Most important of all, however, is the underlying premise of inclusive education, which acknowledges the significance of every individual within the education process.

Much of what is deemed as instructional practice in public education has been in place since the industrial revolution. School jurisdictions and in particular teacher training programs will have to adopt a more flexible approach to imagining new worlds and anticipating the future needs of teachers and students. As we take leaps of imagination, we begin building the worlds where these new ideas make sense. Success in the twenty-first century will only be achieved through a willingness to consider new and creative solutions. The needs of twenty-first century learners can only be met through an understanding that change is a constant and that the willingness to embrace the change is the first step in that process. Public education as we know it today is not meeting the needs of twenty-first century learners.

2.7 Twenty-First Century Learning Skills

The needs of twenty-first century learners mandate a sophisticated skillset and mindset on the part of teacher education programs and school jurisdictions whose job it will be to ensure that the needs of students are met. These are just a few of the ICT skills required of twenty-first century learners:

- Have a strong background in psychology and human development.
- Possess comprehensive subject matter knowledge.
- Know how to communicate effectively (face-to-face; email; instant messaging; social networking) and be able to make presentations in large groups both in person and online.
- Possess knowledge of instructional strategies and processes, including: problem-based learning, group-based learning, authentic tasks, criterion-based assessment, and ways to manage students progressing at different rates (inclusion).
- Be able to facilitate group processes and group work.
- Understand the process by which instruction is designed to accommodate inclusive practice.
- Be aware of research based best practices.
- Understand how to incorporate technology as a resource into the learning environment.
- Ensure equitable and inclusive access and availability to instructional resources for all students.
- Have the necessary ICT skills to ensure competency for the following: (1) planning for inclusive student learning; (2) delivery of appropriate instruction for learning, for traditional, blended and online learning environments; (3) appropriate assessment for learning practices; (4) install and run computer software.
- Develop instructional materials using digital technologies (Luterbach and Brown 2011).

Research in utility for ICT has shown that when available and provided within a secured learning environment in which to work, increased student engagement that facilitates self-directed learning behaviors is most often accomplished through online assignments (Strom et al. 2009). Within a few short years, the quality of public education as we know it today will be determined by the degree to which students demonstrate twenty-first century learning competencies. This can only be accomplished through the use of ICT.

Acknowledgments Aspen View Public School Division No.78, Athabasca University.

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Author Biography

Dermod Craig Madden I have been a student or a teacher my entire life. As a teacher, principal, director and superintendent I have learned a great deal about curriculum, instruction and leadership. Now, as a doctoral student at Athabasca University I am learning about the importance of distributed learning and the paradigm shift that is occurring in education today, and for the foreseeable future. I am married and have two children. We live on an acreage in Athabasca, Alberta.

Chapter 3
Classroom Assessment: A Key Component to Support Education Transformation

Jon K. Price, Daniel Light and Elizabeth Pierson

Abstract Through global assessment reform initiatives like the Assessment and Teaching of twenty-first century Skills (ATC21S) and the Collaborative Assessment Alliance, Intel® has been working alongside governments and policy-makers to create new national standards and national assessments. But understanding how classroom assessment can support education transformation is also the result of research on how Intel's professional development (PD) programs help teachers use assessment for learning as part of a twenty-first century learning environment. In this paper, we highlight the research on six assessment strategies that should be part of a twenty-first century learning environment and encourage ministries to consider how these strategies may play a role in their own reform efforts: (1) Rubrics, (2) Performance-based assessments (PBAs), (3) Portfolios, (4) Student self-assessment, (5) Peer-assessment, and (6) Student response systems (SRS).

Keywords Classroom · Assessment · Reform

3.1 Introduction

Student assessments, once thought of primarily in terms of standardized tests are now increasingly recognized as classroom-based measures of student performance, critical for effective teaching and learning. Although traditional high-stakes

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R. Huang et al. (eds.), *ICT in Education in Global Context*,
Lecture Notes in Educational Technology, DOI: 10.1007/978-3-662-43927-2_3

assessments are still considered to be the most reliable measures of a student's content knowledge and comprehension, a change in assessment strategy is needed to meet the needs of increasingly global, and technology-rich twenty-first century critical thinking and problem solving. Teachers understand how classroom-based assessment strategies can benefit their teaching practices and their students' learning, but practice has been shaped by the policy demands of summative assessments.

For more than four decades, Intel Corporation has made education the primary focus of its strategic philanthropic activity. The corporation has invested more than $100 million US annually in programs that promote education, encourage women and girls to seek careers in technology, foster and celebrate innovation and entrepreneurship among the best and brightest young students in the world and help teachers to incorporate best practices and the effective use of technology in their work. As a result of participating in the Intel© Teach professional development (PD) program they learn how to plan, develop, and manage student-centered assessment and learn from other teachers who are implementing embedded and ongoing assessment methods in their classrooms. To date, the Intel Teach Program has trained over ten million teachers in more than 70 countries worldwide.

In addition to program and infrastructure investments, Intel has also invested in exploratory research and rigorous program evaluation to establish and sustain continuous improvement of these educational products and activities. The research and evaluation compiled for this purpose has not only enabled the improvements of the program development efforts, but now also comprises a comprehensive body of evidence that demonstrates program impact (Price et al. 2011). This data has provided critical evidence to inform classroom-based student assessment and has extended into other efforts designed to transform education strategy.

3.2 Intel Education Transformation and Assessment Reform

As a result of the research and evaluation efforts that have supported these education programs, the need for a comprehensive approach to systemic education reform became clear. Intel's model of education transformation is a systemic approach that supports best practices for achieving reform, and is based on data collected over 10 years examining educational policy and practice.

Intel has combined advocacy for policy reform, leadership, curriculum standards and assessment, sustained PD efforts, information and communications technology, support of research and evaluation, and sustainable resourcing to help countries create an effective approach to twenty-first century education. Components of the Intel Education Transformation Model include:

- Leadership—People respond to leaders who envision better outcomes, communicate them clearly, and implement a defined path to completion. It is important for organizations to support effective, empowered decision makers at multiple levels.

- Effective policies—Transformative policy is systemic, aligned, action-oriented, and sustainable. Reform efforts based on scalable policies that protect students, maintain data privacy, and advance teaching and learning with technology are critical.
- Information and communications technology (ICT) programs—ICT provides the foundation for systemic transformation. ICT delivers the tools needed to enhance teaching and learning and support student-centered learning environments.
- Professional development—Educators, like students, succeed when given the proper tools, training, and inspiration. PD resources that make the most of modern, personalized learning environments and technology tools enable effective use of tools provided.
- Research and evaluation—It is important to assess, refine, and improve the components of your educational programs continuously. Successful education reform should be based on future outlook, and should incorporate program data from the outset in regular evaluations and measurements.
- Sustainable resourcing—Wise technology choices set a path for long-term sustainability. Combining digital curriculums, online assessment, and classroom and learning management systems can improve resource and time management for more personalized learning.
- Curriculum standards and assessment—To ensure that students gain critical skills and knowledge to succeed, combine strong curriculum standards with accurate assessments. The result is more effective measures of students' knowledge, skills, and progress across various subjects.

A systemic model for education transformation is achievable by bringing together not only the right set of decision makers, but also the critical, essential areas impacting quality education practice. Intel is active in all these areas, and recognizes from experience and research that each component is required for effective systemic change—providing the technologies, tools, programs, and resources for success in diverse educational environments worldwide. This paper presents effective classroom based-assessment tools to inform teacher day-to-day practice and inform student centered instruction.

3.3 Assessment for Learning as a Catalyst for Change in Emerging Market Countries

Teachers have always assessed student knowledge with strategies such as recall tests or by asking content questions during a lecture, but researchers and practitioners are beginning to understand that other types of assessments can play an important role not only in supporting learning (Black and William 1998; Hattie and Timperley 2007; Popham 2008), but also in actually helping to transform teaching practice. *Assessment for learning*, the term we will use, is the idea that classroom assessments should support ongoing teaching and learning

(Assessment Reform Group 2002; Heritage 2010); should be administered frequently; should be embedded into the learning process (Black and William 1998); and can be effectively developed by classroom teachers (Popham 2008). The research cited below highlights the vital role that teacher-made, classroom-based assessments can play in transforming teachers' practice and ultimately improving teaching and learning. Black and William (1998) have found found that assessment for learning is one of the most powerful interventions available to improve student outcomes. In fact, in order to change daily teaching practices, teachers should *start* by updating their arsenal of assessment strategies (Jacobs 2010). In a seminal review of the literature on how people learn, the National Research Council asserts "appropriately designed assessments can help teachers realize the need to rethink their teaching practices" (Bransford 2000, p. 141).

Despite the potential for assessment for learning practices to improve teaching and learning, there is little focus on promoting their use in emerging market countries. Assessment for learning strategies are becoming increasingly common in the richer countries of Europe, North America, and Australasia (Assessment Reform Group 2002; Hume and Coll 2009; Organization for Economic Co-operation and Development 2005; Sluijsmans et al. 2004), but the research we have found in emerging market countries suggests that these practices are barely used, if at all, and in many countries they are not even part of the conversation.

3.4 Intel Evaluations Show Assessment for Learning Work in Emerging Market Countries

Over the past 10 years, through evaluation efforts for the Intel Teach teacher PD programs,[1] our observations suggest that many classroom assessment strategies *can* work within the contextual challenges that teachers in emerging market countries often face—large class size, short lesson periods, and limited resources. We have been able to observe the use of assessment for learning approaches in classrooms in countries as diverse as India, Turkey, Chile, and Costa Rica (Light and Rochmann 2008; Light et al. 2009; Light 2005). In our fieldwork with teachers trained through the various programs, we have seen assessment practices ranging from student- and teacher-designed rubrics in Chile to PBAs in Turkey and India.

As an accompaniment to our own empirical research, and to assess the extent of current efforts to support these strategies in emerging market countries, we conducted a brief literature scan for published research in English, Spanish, French, or Portuguese about assessment for learning strategies in countries in Sub-Saharan Africa, Latin America, East Asia, South Asia, and Southeast Asia. We limited our search to five common strategies: rubrics, PBA, portfolios, self-assessment, and peer assessment. The literature scan suggests that many ministries are thinking

[1] The portfolio of programs we have evaluated include: The Essentials Course, Getting Started, Teaching Thinking with Technology, and the Leadership Forums.

about the topic, but there is still little research around these practices in emerging market countries and few concerted efforts to promote their use (Braun et al. 2006; Kellaghan and Greaney 2003). Much of the effort on assessment is focused on national examinations (EFA Global Monitoring Report Team 2004). In East Asia and Southeast Asia, most countries have well-established examination systems in place whose high-stakes social functions, such as gaining admission to university, make it hard to move away from these traditional approaches (Fok et al. 2006). Additionally, the fact that countries such as Singapore, Korea, and Japan consistently top the lists on international examinations such as PISA or TIMMS adds validity to examinations (Tsuneyoshi 2004). The Spanish- and Portuguese-speaking countries in South America have developed new standardized assessments of student learning at the national levels and also new regional assessments (Valdés Veloz et al. 2009). But the limited amount of research on classroom practice finds that most teachers still use traditional assessment approaches (Chisholm 2004; Nenty et al. 2007; Otiato Ojiambo 2008; Prieto and Contreras 2008; Saldanha and Talim 2007; Vandeyar and Killen 2007; Zamora Hernández and Moreno Olivos 2009).

These approaches have a proven impact in a variety of wealthy countries and, we assert, can be similarly effective across a range of developing-country contexts. There are four main dimensions of teacher-made classroom assessments that the literature suggests can effectively push teaching and learning into the twenty-first century:

1. *Provide insight on student learning so teachers can modify instruction*. Because many of these assessment tools and strategies are formative in nature, the information garnered from their implementation can be used to immediately inform teachers' instructional decisions (Heritage 2010). The teacher can use information collected during the learning process to evaluate her own teaching and make changes to future lessons around the needs and goals of those students. As teachers become more aware of their students' interests, needs, strengths, and weaknesses, they are better positioned to modify their instructional strategies and content focus to help maximize student learning.
2. *Assess a broader range of skills and abilities to provide a more robust portrait of student ability*. Traditional forms of assessment, such as multiple-choice, fill-in-the-blank, and true/false, privilege memorization, and recall skills that demand only a low level of cognitive effort (Dikli 2003; Shepard et al. 1995). The assessment tools and strategies outlined in this paper provide more robust means to measure higher-order thinking skills and complex problem-solving abilities (Palm 2008). Strategies such as PBA and portfolios take into account multiple measures of achievement and rely on multiple sources of evidence, moving beyond the standardized examinations most commonly used for school accountability (Shepard et al. 1995; Wood et al. 2007). Self- and peer-assessment both teach and assess a broader range of life skills, such as self-reflection, collaboration, and communication. As a tool to measure student learning, rubrics allow teachers to measure multiple dimensions of learning rather than just content knowledge and to provide a more detailed assessment of each student's abilities instead of just a number or percent correct.

3. *Offer students feedback about their learning and guidance on how they can improve.* Giving feedback to students about their current knowledge, abilities, or performance, the desired level of knowledge, abilities, or performance, and the gap between the two is a critical function of formative assessment (Hattie and Timperley 2007; Sadler 1989) if it is to improve teaching and learning. Effective feedback should collect information about how and what students understand and misunderstand and allow teachers and students to find directions and strategies to improve (Hattie and Timperley 2007). The feedback should also help students understand the goals of their learning. This is especially important when we are talking about complex learning outcomes that are not measured by content recall tests (Sadler 1989). Final course grades, for example, are at such a distance from the day-to-day learning activities that students would not be able to identify specific strengths or weaknesses in knowledge or abilities, and that type of grade would not help them reflect on which learning strategies or practices had been most or least beneficial for them.
4. *Give students new roles in the assessment process that make assessment a learning experience*. In contrast to the traditional teacher-designed, teacher-administered, teacher-graded tests, assessment for learning strategies give students active roles throughout the assessment process. Involving students in the creation of assessment criteria, the diagnosis of their strengths and weaknesses, and the monitoring of their own learning transfers the locus of instruction from the teacher to his or her students (Nunes 2004). Giving students these new roles fosters metacognition and active participation, and ultimately puts students at the center of the learning process (McMillan and Hearn 2008). During peer assessment, students are asked to be the actual evaluator offering feedback and suggestions on how to improve their classmates' work. When created collaboratively, many of these assessments enable teachers and students to interact in a way that blurs the roles in the teaching and learning process (Barootchi and Keshavarz 2002). When students are part of the assessment process, they are more likely to take charge of their own learning process and products and will be more likely to want to make improvements on future work (Sweet 1993).

3.5 Six Effective Assessment Strategies

There are many instructional practices and tools that could be classified as assessment for learning, but here we present six broad categories that can be easily promoted through the Teach PD programs, and which we feel they may be effective in typical classroom contexts of many emerging market countries. All of these strategies can be used with the whole class. They do not require teachers to tailor the assessment for each student, yet the assessment still provides personalized feedback. We felt this was important for teachers with many students. The six assessment tools and strategies are: (1) rubrics, (2) performance-based assessments (PBAs), (3) portfolios, (4) student self-assessment, (5) peer assessment, and (6) student response systems (SRS). Furthermore, it is important to note that these strategies also overlap in a variety of ways (Table 3.1).

Table 3.1 Six effective assessment strategies

Tool	Advantages	Disadvantages	Examples
Rubrics	A rubric allows teachers to measure certain skills and abilities not measurable by standardized testing systems that assess discrete knowledge at a fixed moment in time (Reeves and Stanford 2009). One of the major strengths of the rubric as an assessment method is that it functions as a teaching and an assessment tool (Andrade et al. 2008; Popham 1997)	One criticism is that it is not always easy or possible to test rubrics for validity and reliability, particularly the case with those that are developed locally, (Stein and Haynes 2011) Furthermore, simply handing out a rubric to students before an activity does not guarantee any learning gains because students must deeply understand and value the criteria (Andrade and Valtcheva 2009)	Research on the Intel Teach professional development programs, for example, finds that teachers in almost all countries are interested in learning about and using rubrics: On a survey of over 9,000 participants in 16 countries, 57 % of respondents reported increasing their use of rubrics (Light et al. 2006)
Performance-based assessments	Performance-based assessments (PBA), also known as project-based or authentic assessments, are generally used as a summative evaluation strategy to capture not only what students know about a topic, but if they have the skills to apply that knowledge in a "real-world" situation. By asking them to create an end product, PBA pushes students to synthesize their knowledge and apply their skills to a potentially unfamiliar set of circumstances that is likely to occur beyond the confines of a controlled classroom setting (Palm 2008)	Principles to guide constructive feedback contained within performance-based assessments must become part of the everyday practice of educators if students are to gain the best outcomes from these authentic assessment activities (Taylor and McCormack 2007)	PBA is another assessment for learning strategy presented in the Intel Teach courses that we have seen widely adopted among participant teachers. On the teacher survey in 2005, 67 % of participants in 16 countries increased their use of PBA (Light et al. 2006). Most of the PBA activities that we observed in various field studies of the Intel programs in emerging market countries generally consisted of students presenting PowerPoint presentations on research and taking questions from peers, although we have seen students in Turkey and India give presentations to parents and the community (Light et al. 2009)

(continued)

Table 3.1 (continued)

Tool	Advantages	Disadvantages	Examples
Portfolio assessment	Portfolios are a collection of student work gathered over time that are primarily used as a summative evaluation method. The most salient characteristic of the portfolio assessment is that, rather than being a snapshot of a student's knowledge at one point in time (like a single standardized test), it highlights student effort, development, and achievement over a period of time; portfolios measure a student's ability to apply knowledge rather than simply regurgitate it. They are considered both student-centered and authentic assessments of learning (Anderson and Bachor 1998; Barootchi and Keshavarz 2002)	Research remains scarce on portfolio validity. Little research has been done to demonstrate that portfolios are superior tools for assessment. Educator rating of student performance remains, at this time, largely objective (Cho 1999)	Technology is playing an increasingly important role in enabling teachers to use portfolios. In the past decade portfolios have moved from paper folders and file cabinets to electronic databases in social networks imbedded within the online "cloud." While e-portfolios offer many of the same benefits of conventional portfolios, there are additional advantages that affect learning, teaching, and administration. Chang (2009), p. 392 describes the e-portfolio as an "abundant online museum," connoting an ease of storage, a creativity of presentation, and the facilitation of collaboration
Self-assessment	Self-assessment main purpose is for students to identify their own strengths and weaknesses and to work to make improvements to meet specific criteria (Andrade and Valtcheva 2009). According to McMillan and Hearn (2008), p. 1 "self-assessment occurs when students judge their own work to improve performance as they identify discrepancies between current and desired performance"	In order for self-assessment to be truly effective, four conditions must be in place: the self-assessment criteria is negotiated between teachers and students, students are taught how to apply the criteria, students receive feedback on their self-assessments, and teachers help students use assessment data to develop an action plan (Ross 2006, p. 5)	A number of channels can be used to aid students in their self-assessment, including journals, checklists, rubrics, questionnaires, interviews, and student-teacher conferences. As with the previous assessment strategies, the rubric is often the most effective tool to help monitor and measure student self-assessment

(continued)

Table 3.1 (continued)

Tool	Advantages	Disadvantages	Examples
Peer assessment	Peer assessment, much like self-assessment, is a formative assessment strategy that gives students a key role in evaluating learning (Topping 2005)	Similar to Self-assessment, it is also important to create a classroom climate in which students feel comfortable assessing themselves publicly. Educators should focus students' attention on learning goals (with a focus on learning ideas) rather than performance goals (that tend to focus on outdoing one's peers) (Ross 2006: 5)	Peer assessment approaches can vary greatly but, essentially, it is a process for learners to consider and give feedback to other learners about the quality or value of their work (Topping 2009)
Student response systems	Student response system (SRS), also known in general terms as "clickers," refers to a variety of technology-based formative assessment tools that can be used to gather student-level data instantly in the classroom	As with most teaching tools (including the rubric), an SRS is only as effective as the pedagogy in which it is couched (Beatty and Gerace 2009; Rochelle et al. 2004). As a result, this section discusses not only the tool but also the questioning strategies at the heart of its implementation	Through the combination of hardware (handheld clickers and increasingly cell phones, receiver, PC, internet connection, projector and screen) and software, teachers can ask students a wide range of questions (both closed and open-ended), students can respond quickly and anonymously, and the teacher can display the data immediately and graphically. The value of SRS comes from teachers analyzing information quickly and then devising real-time pedagogical solutions to maximize student learning (Beatty and Gerace 2009; Bruff 2007; Caldwell 2007)

3.6 Addressing Concerns About Reliability

Reliability is the most frequently cited challenge associated with teacher-developed assessments, but this partly misconstrues the function or purpose of assessment for learning. Reliability—the degree to which a test consistently measures student knowledge—is a greater concern for summative assessments that are used to categorize or track students (Sadler 1989). Assessment for learning is formative; it is part of the learning process (Heritage 2010) and feeds back directly into changing students' knowledge. Accordingly, the purpose of assessment for leaning is to provide evidence that teachers and students can then use to guide learning. The research is fairly consistent that effective feedback to learners focuses on what they need to do to improve, and that comparing students can be counterproductive (Wiliam 2007).

However, there are important issues to consider in ensuring that criteria are demanding and clear, and that teachers and students can apply these criteria across a wide range of products or activities (Wren 2009; Darling-Hammond and Pecheone 2009). For example, creating an appropriate scoring model or rubric can help increase consistency, while Wren (2009) actually suggests field-testing the assessment criteria before they are implemented in a classroom. Rubric performance standards are open to interpretation; in order to ensure that all students are aiming for a similar quality of work, researchers and practitioners recommend the use of a sample product or model to help ensure more standardized interpretation of the desired outcome (Andrade et al. 2008; Wiggins and McTighe 2005).

Both self- and peer-assessment methods are also criticized for having potentially low reliability, based on the possibility that students will increase their assessment measures based on unrelated and inflated perceptions of achievement (Ross 2006). Some reviews raise concerns about validity when peer assessors are untrained (Dochy et al. 1999), but other surveys of the research consider that peer assessment has sufficiently high validity (Topping 1998, 2010). However, concerns about validity are mediated by the fact that both self- and peer-assessment are steps in a longer learning process and rarely the final grade; students do not replace the teacher's role in providing summative assessment, they provide an additional dimension.

3.7 Assessment for Learning as a Global Imperative

Assessment for learning is the idea that classroom assessments should support ongoing teaching and learning (Assessment Reform Group 2002; Heritage 2010) thus highlighting the vital role that teacher-made classroom-based formative and process-focused assessments could play in improving the entire education system. Many of these assessment strategies are increasingly common in the classrooms of emerging market countries, but rarely used in emerging market countries. To truly improve student learning in emerging market countries it is important to transform how teachers assess their students learning in the classroom.

The six assessment tools and strategies that have been discussed overlap not only in the ways in which they can push teaching and learning into the twenty-first century, but also in the types of supports that are needed to make that push successful. While all of the assessment strategies and tools discussed can be developed by a teacher in his or her classroom, in order to maximize the impact on teaching and learning teachers require support beyond the confines of the classroom walls. School administrators, as well as leaders at the local, state, and even national levels, must be prepared to offer various types of supports, including research and development grants, relevant PD, sufficient planning time, and access to high-quality resources. Moving beyond standardized testing and single-grade assessment used currently as indicators of learning at a single point in time, is a step in the right direction. However, the adoption and integration of classroom-based assessments designed as ongoing components of the learning process will be truly successful only if leaders take the vital next steps in ensuring that these necessary supports are in place.

Intel supports *assessment for learning* in many of its established teacher PD programs and encourages ministries to consider how these strategies may play a role in their own reform efforts. However, Intel also recognizes the importance of new global initiatives to assist leaders in transforming the most common use of student assessment, most often recognized as high stakes benchmark exams. These new initiatives utilize assessment for learning strategies as tools to empower students with the right skills to succeed in the twenty-first-century. Working in collaboration with other technology companies, development, and implementation of the tools and resources needed for classroom use are underway.

One such initiative is the global partnership, known as the Assessment and Teaching of twenty-first century Skills project, (ATC21S.org) that supports developing new national assessment strategies and new benchmarking tests. This collaborative effort involving more than 260 international researchers, developers, education specialists, practitioners, and other experts helped define policy implications, methodological issues, technology considerations, and broker common standards, assessments, and terminologies in twenty-first century skills around the world. Where the importance of twenty-first century skills were previously noted as important, the ATC21S project provided, "a system for understanding them, measuring them, reporting them, and helping teachers teach to them, whether at the individual, class, or system level (ATC21S 2013)." A collection of research papers has been produced to describe these methods and measures.

More recently, the work of the Collaborative Assessment Alliance (CAA21.ORG) extends the research and outcomes of the Assessment and Teaching of twenty-first century Skills project. Designed to build local ecosystems of knowledge and expertise in creating new types of assessments, this global multi-stakeholder collaboration is made up of a number of a member networks at local district, state, or country level, each working with experts to create collaborative assessment tasks, to measure twenty-first century Skills (Collaborative Assessment Alliance 2013).

3.8 Conclusion

These findings, based on over a decade of study, help illustrate how to transform teaching and learning for millions. One effective way is working through public/private partnerships between industry, NGOs, countries, communities, and schools worldwide to bring the resources and solutions needed for effectively integrating technology into educational systems to promote problem solving, critical thinking, and collaboration skills among students. In its work collaborating with governments, policy-makers, and local agencies around the world, Intel has always maintained that education reform is a systemic process, which stakeholders need to consider how policy changes in one area affect other areas. The consequences of making incomplete, poorly coordinated reforms could be tragic. One of the biggest challenges for ministries of education engaged in school reform is measuring whether they are having a real impact in the classroom. Viewing assessments as an external additive process misses out on the opportunity for assessments that focus on the effects of the teacher's direct actions and practice within a participatory classroom with the goal of improving the performance quality of the learners. Weaving technology into these reforms allows schools to monitor and measure academic performance where teaching and learning occurs.

Education reformers in the developed nations are paying increasing attention to the role that classroom-based assessment strategies play in fostering student-centered teaching practices, but this conversation is only beginning in emerging market countries. While the focus on reforming national tests should not be abandoned, we urge ministries, education administrators, researchers, and teachers to broaden their view and deepen their conversation around the use of classroom-based assessments to consider moving beyond assessments as a tool to obtain benchmark indicators, moving toward assessments for learning. Together, all of the research cited here strongly suggests that these assessment tools and strategies can positively affect a number of key areas that we know are important aspects of education reform: student/teacher relationships, teacher's ability to personalize instruction, acquisition of twenty-first-century skills, student engagement, and student metacognition.

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Chapter 4
Case Studies of Russian Educators Transforming Classroom Practices Through ICT-Rich School Environments

Daniel Light and Elizabeth Pierson

Abstract Research suggests that the integration of ICT into teaching moves in phases from the enrichment of existing practices towards more innovative teaching practices. Our research focuses on the experience of two Russian schools that are using the laptops daily to explore how these educators are enriching and transforming Russian educational practices. The impacts of these tools can be seen in classroom practice, student engagement, peer collaboration, assessment, and communication with parents, which in turn, has shifted the dynamic between teachers and students and helped foster a more personalized and humanistic learning environment. Although both Russian schools developed their own approaches to using laptops, there are common elements supporting their success. First, the emerging ICT-rich practices are the result of careful instructional decisions being made at the school level. Both schools are taking advantage of external resources and training, but the actual classroom practices are supported by principals and are carefully tailored and embedded in the classroom by the teachers. Successful integration is a deliberate process, guided by strong principals and administrators working closely with their teachers, who together carefully move these new tools into their practice. The principal is able to set a vibrant and coherent school culture that welcomes innovation, while the teachers figure out how the device compliments their goals and lessons.

Keywords One-to-one learning · Russian education · Technology integration · Laptops

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R. Huang et al. (eds.), *ICT in Education in Global Context*,
Lecture Notes in Educational Technology, DOI: 10.1007/978-3-662-43927-2_4

4.1 Introduction

This chapter seeks to inform the broader discussion around the challenges of helping teachers use laptops by inverting the standard question—Why do many teachers *not* utilize the laptop resources? The research on large-scale laptop programs around the world has frequently found that the laptops were not used in many classrooms (Kraemer et al. 2009; Winthrop and Smith 2012) echoes most of the Russian experience with laptop programs (Nikolaev and Chugunov 2012). Instead, we investigate how a few exemplary schools that are using laptops have integrated these new tools into their classroom practice. In this chapter, we explore the daily use of laptops in the classrooms of two Russian schools. In both schools, we saw how the laptops and information and communication technology (ICT) resources had become a daily part of learning in the classroom.

In April 2012, we traveled to Moscow and Nizhny Novgorod to develop case studies of two schools that have one-to-one laptop initiatives. Although both schools have developed their own laptop programs, the core of their programs are classroom sets of netbooks (Intel® Classmate PCs[1]), interactive whiteboards (IWB) or projectors, wireless Internet access, and virtual learning environment.

4.1.1 Socio-Cultural Theory of Learning and the Role of Educational Tools

Research indicates that the integration of technology into instruction occurs over time and follows a pattern (e.g., Sandholtz et al. 1997). In their work focused principally on schools in developed, Western countries, Zhao and Frank (2003) have suggested that the process of technology integration is an evolutionary one where teacher's beliefs, pedagogy, and technology skills co-evolve as technology is introduced and assimilated into the school culture (p. 14). Initially, they argue, teachers incorporate new technologies into existing practices and if teachers begin to see improvements in engagement, behavior, or learning, they may be motivated to experiment further with newer uses of technology to teach in new ways.

To explore this process of adoption and integration of new ICT tools into Russian classrooms, we grounded our work in a socio-cultural theory of learning (Vygotsky 1978). A socio-cultural perspective envisions learning as a social process, wherein individuals develop and grow intellectually in interaction with other people and *tools* play a fundamental role in mediating all human action. For Vygotsky, the term *tool* encompasses everything from human language and number systems to books and automobiles. Tools are fundamental to supporting learning. We understand this to mean that teaching and learning utilizes a wide range of artifacts (i.e., pens, books,

[1] Intel Classmate PC, Essentials Course, Getting Started, Skills for Success and Education Galaxy are trademarks of Intel Corporation in the U.S. and/or other countries.

copybooks), semiotic systems (i.e., language, images, diagrams), social interactions (i.e., group work, teacher–student questioning), and institutional structures (i.e., education policies, laptop programs). Furthermore, these tools and teaching strategies mediate the students' engagement with the content. Tools are embedded in all classroom practice and they shape everything that happens. An important insight that grounds our work in ICT is that ICTs represent new sets of tools that replace, displace, or combine with previous tools and strategies. The Classmate PCs and other new tools may be used in new ways, or they may be spliced into old practices.

4.1.2 Russian Education Context

After the end of the Soviet Union, the Russian education system entered a long process of reform. In the West and in the developing countries, reform is typically understood to be about improving educational standards and outcomes and, in the case of developing countries, providing more and better resources to the system. In Russia, except for a period of extreme economic crisis in the 1990s, the education system has been generally high-performing (Gonzales et al. 2008; U.S. National Center for Educational Statistics 1999) and sufficiently resourced (Alexander 2001; Johnson 1996). The central challenge of reform was to meet the emerging needs of society as Russia experienced profound changes in its political and economic structures (Kuzmenko et al. 2006; Russia. Ministry of Education and Science of the Russian Federation 2001a).

The education reforms undertaken by the new Russian Federation focus on transforming a rigidly centralized Soviet education system concentrated on meeting the needs of the Communist state into a system that is decentralized, more responsive to local and regional concerns, and built around the needs of learners and a market economy (Pogosian 2012). At the time, the reforms sought to "develop students" capacity for independent decision making, critical thinking and democratic citizenship" (Johnson 1996, p. 122).

The current framework of reforms was launched in 2010 under the name "Our New School" (Nikolaev and Chugunov 2012) and takes a more system-wide approach to reform. The initiative is built around six principal approaches to creating a more comprehensive education system, including adopting new educational standards, developing a comprehensive student support system, improving school infrastructure, maintaining school children's health, expanding individual school's independence, and cultivating talented teachers who are qualified to teach in these twenty-first-century schools.

4.1.2.1 Technology in Education

Though not specifically mentioned in the current education reform framework, technology plays two roles in Russian reform: training computer scientists and ICT professionals; and broader digital literacy among the populace. In relation to the first goal, Russia

had a long history as an engineering and technological powerhouse (Semenov 2003), and the government seeks to reclaim that by having strong computer science departments. Russia made computer science a required content in high school. A clear goal is "affirming Russia's status in the world community as a great power in […] high technology" (Russia. Ministry of Education and Science of the Russian Federation 2001b, p. 11). Toward the second goal, the federal government understands that developing technology skills and competencies is critical for a successful life (Nikolaev and Chugunov 2012; Pogosian 2012), however research suggests this goal has not been met.

One possible explanation for these unmet goals, according to ICT policy experts, is that the policy context supporting the development of the ICT sector in Russia is unclear, poorly structured, and undermines the countries potential (Biktimirov and Sher 2013). As a nation, the Russian Federation ranks 40th on the ICT Development Index (IDI), which ranks countries' performance with regard to ICT infrastructure and uptake (International Telecommunications Union (ITU), 2013). Overall, the region of the Commonwealth of Independent States (CIS) ranks below every other region but Africa. This weak policy environment extends to national educational ICT policies.

Similarly, while the National Education Doctrine of 2000 laid out the goal of ensuring students' and teachers' access to ICT (Russia. Ministry of Education and Science of the Russian Federation 2001b, p. 15), it did not map out effective policies to achieve that goal. The national government has only provided partial funding (Semenov 2003) and many initiatives are forced to rely on private capital. For example, a large teacher-training program—the Federation of Internet Education—was funded by a private company and after a few years of success the project just stopped (Anderson and Zlotnikova 2009; Semenov 2003).

In practicality each Russian school has to build its own technology infrastructure and integration plan; the federal government provides very little of the equipment or instructional resources. A recent World Bank study (Nikolaev and Chugunov 2012; World Bank 2008) found that Russian schools have had reasonable success building the school-level infrastructure, but research finds that technology use is frequently limited to computer class and underutilized (Nikolaev and Chugunov 2012).

Other Federal guidelines, however, are an important factor influencing the way teachers use computers with their students. Regulations from the Russian Ministry of Health recommend a limit on the amount of time children are on computers: 15 min per day for students in grades 1–4; 20–25 min for grades 5–9; and 30 min for grades 10–11 (Russia. Ministry of Health 2003). Both the schools we visited adhered to these recommendations and, therefore, the teachers were very deliberate and careful about how they brought technology into their classrooms.

4.1.2.2 Inside Russian Schools

The structure of the school system in Russia is unique. The most common form of schools are large all-age schools that go from 1st to 11th grade (Alexander 2001), which means that most students are at the same school their entire schooling.

Elementary education goes from 1st to 4th grades, and students stay with the same teacher for all four grades. The classes in middle school (5th–9th grade) and secondary school (10th and 11th grades) are departmentalized and students move between classrooms. In these grades, teachers in most content areas have specialized classrooms where they have access to the tools and resources needed to teach their content areas. Students attend school six days a week. Typically, the school day goes from 8:00 a.m. to 12:00 or 1:00 p.m., and students will attend anywhere from six to eight classes a day. Elementary students will study from 5–7 subjects per semester, while middle and secondary students study up to 14 unique subjects. Many students return to school in the afternoon for sports, clubs, and additional academic support.

Research on Russian education and classrooms shows there are a few common aspects to many, if not most, Russian classrooms. In comparative studies with the West, Russian teachers tend to use more whole-class approaches, and learning activities tend to be very tightly designed and structured by the teacher to be interconnected. The learning activities are tightly focused on the standards and content coverage (Alexander 1999, 2001; Elliott and Tudge 2007; Hufton and Elliott 2000; Hufton et al. 2002). Lessons tend to move through a cycle of steps from introducing the lesson, recalling or consolidating prior knowledge, presentation of new material, hands-on practice, reinforcement, and assessment. Indeed, almost every lesson we observed went through these steps.

In addition to the ICT resources and skills courses, nearly all teachers at the schools we visited have access to their own, well-resourced classrooms with books, posters, art supplies, and other educational manipulatives. This sustained access to high-quality educational resources, coupled with the increased access to technology, has changed what teachers are able to do in their classrooms.

4.2 Methodology

This study used an instrumental case study approach (Stake 1995) with a very simple focus: to observe the classroom experience of students and teachers in schools where students are using laptops daily, and to document the types of practices emerging around these tools. After more than 10 years offering teacher training programs around the world as part of its corporate social responsibility program, Intel® has a broad network of teachers and schools across the globe who are using technology. To find possible sites, EDC coordinated with the Intel education manager in Russia and the local training agent, Project Harmony (http://www.ph-int.org) to access their network of technology using schools and identify two exemplary schools where they knew the laptops were being used daily.

The case studies were developed over two days of visits at each school. We interviewed school leaders, classroom teachers, parents, and students; and observed classes (Table 4.1).

Of the 16 teachers we interviewed, 15 were women. The teachers were mostly experienced educators: at the Moscow school the average experience was 15 years;

Table 4.1 School visits

School	Subjects interviewed				Classes observed
	School leaders	Teachers	Students	Parents	
Moscow	3	8	6	6	8
Nizhny Novgorod	7	8	13	5	9
Total	10	16	19	11	17

and in the Nizhny Novgorod school the average of 19 years and, on average. Most of the observations were elementary and middle school classrooms; only two were high school classrooms.

4.3 The Schools

The two schools we visited were selected because they represented different contexts: a densely urban neighborhood in central Moscow and an industrial town of 50,000 people in the Nizhny Novgorod region.

The school we visited in Moscow is ranked as one of the best public schools in Moscow. The director said they are known for their innovative learning environment and programs—one of which is the laptop program. There are 800 students and 100 teachers in addition to the director and her staff of vice-directors and administrators. The school has one building for the elementary and middle grades and another building for the high school. Although old, the buildings are well-maintained, bright, and airy, with ample space for classes, clubs, athletics, and cultural activities. The school has a computer lab, but it also has one-to-one environments in the classrooms.

The second school is located in a small industrial town about an hour outside Nizhny Novgorod, Russia's third-largest city. There are 52 teachers for 900 children from 1st to 11th grades. The school is a four-storey building with a large front yard with trees and grass field, as well as an ice rink and a soccer field in the back. The school also has a library, a gym, a computer lab, a cafeteria that also serves as an auditorium, and a number of science labs. Teachers and parents alike noted that most of the parents whose children attended this Nizhny school have university degrees. This school is considered an exemplary school among the community. While the other schools in town have computer labs, this school is the only one with a one-to-one laptop program.

Russian schools all follow federal curriculum standards, but each school sets the teaching methods. At both schools, we observed teachers deliver complex and rigorous lessons with computers integrated seamlessly into the curriculum, and students were disciplined and engaged. Both schools go from 1st to 11th grade and classes go from 8:30 to 12:00 or 1:00, although both schools remain open after classes for clubs and sports activities. The case studies below outline in more detail the technology infrastructure and support, the classroom practices, and the impact of ICT on students and parents observed at each school.

4.3.1 Technology Infrastructure

Teachers and students at both school had access to a variety of technology tools. While the Moscow school had many more computers available, both schools were able to use a one-to-one model when the laptops were used in the classroom. Teachers in both schools also had access to an interactive whiteboard in their classroom as well as their own laptop that they could take home for planning and communication purposes. Both schools use the government's electronic record book system (the All-Russian e-record book) to manage assignments and communication across teachers, students, and parents.

Moscow: Every classroom from 1st to 9th grade at the Moscow school had a set of netbooks (825 Classmate PCs) for every student. Every teacher also had a laptop computer and an interactive whiteboard or a projector. The school has wireless Internet throughout the building, and was using a virtual learning environment where teachers and students could store and share their work.

The e-learning platform and the All-Russian e-record book create a virtual ecosystem of web-based environments that are essential the daily life of the school. Every teacher and student has their own folder in the e-learning platform, Prometheus. Teachers can upload materials and activities for students. The platform also allows teachers to create online tests and quizzes for students in addition to allowing the school to create summative grade-wide tests. The electronic record book system allows parents to review children's grades and homework daily, to stay in contact with teachers, and to receive teachers' messages via email or cell phone (Yeltsin Presidential Library News 2011). Parents at the Moscow school also used the e-record book to communicate with other parents to coordinate school activities.

Nizhny Novgorod: Currently, the school has 160 computers and wireless Internet throughout the building. There are three computer labs and three laptop carts with either Assus or Classmate PCs. The laptops are shared among the primary grades. The computers are not allowed to go home. All primary school teachers have laptops.

Many of the classrooms also had IWBs. All of the teachers who had interactive whiteboards also had either chalkboards; it was clear that the IWB was just one tool in their larger set of resources.

This school uses the All-Russian e-record book from the federal government. In addition, the school maintains its own website, created by the computer teacher, that offers a message board function where students can talk about school projects and assignments, but it does not have the assessment functionality of the Prometheus system at the Moscow school. But with the Classmate PCs, the teachers can access to the built-in Classroom Management System that networks the machines and on this system they can administer class wide assessments.

After-school access: According to data reported by the school, 93 % of students have access to computers and 83 % have access to the Internet in their homes, an increase from 87 and 60 % in 2010. Students reported that they could always come

to the school to use those resources either after school or on weekends. Older students who do not have access to the Classmate PCs say that they can use the computers in the lab or at their homes to create presentations and do research.

4.3.2 Technology and Classroom Practice

Both of the schools we visited have developed a pedagogical model that is interconnected with their ICT infrastructure, where the technology is an important part of almost every class and where technology can be used anywhere it's needed.

The federally mandated 20-min rule makes the teachers creative and purposeful in the ways in which they incorporate technology into their lessons. The laptop integration varied by grade level and subject area, but all of the observed activities occupied, at most, 20 min within the 45-min classes. However, from interviews with parents, teachers, and students, it was clear that students were also spending substantial amounts of time on a computer for their homework.

Teachers interacted with technology by giving presentations and assessments. Students use the technology for a variety of purposes including doing independent research, creating presentations, and designing projects. As teachers integrate more technology, students are learning technical skills, creativity, collaboration, and independent thinking.

The principal in Nizhny summarized the change in classroom practices commenting, "ICT has changed the way we teach—we know what each child knows and can do. Now teachers can see the results of the success of each student and find the ways to try to help everyone in the school. ICT has helped shape the curriculum and helped each kid grow." The section below outlines the ways in which the teachers and students in Moscow and in Nizhny use the various available technologies.

4.3.2.1 Teacher Technology Use

In most of the lessons we observed, teachers used the whiteboards through out the lessons. In addition to integrating more multimedia presentations into their lessons, ICT also allows teachers to integrate more formative assessments into their daily and weekly practice.

Multimedia resources: When teachers used used the interactive whiteboards (IWB) as part of a whole-class lesson, the IWBs were used to guide teacher lectures as well as to project students' presentations. We did not observe students physically interacting with the touch screen aspect of the board; it was used exclusively for teacher-directed, whole-class instruction.

In a 4th-grade home economics class in Nizhny, for example, a teacher created a PowerPoint presentation about the history of Russian clothing. She used the IWB to project the slideshow that included dynamic images and sound.

The teacher asked various open-ended questions about the history of clothing, about what humans used to wear. She also used images to help explain different fabrics and materials and their purposes. Two dolls repeatedly appeared in the PowerPoint and gave interesting facts about Russian garments. Many different children participated in the conversation and, as a whole, the group was engaged.

Ongoing (*formative*) *assessment*: In Moscow, it is a school policy to build a student assessment into every lesson, all of which are in the online platform. The director explained that the objective was to give students more control over their learning through two types of assessments: Content-based assessments using multiple-choice items or short answer items, with immediate feedback; and self-reflection items on "What have I learned today?", "What could I do to improve?" and so on. For example, in one class, after the assessment was completed, the teachers asked students to indicate whether they had had a good day (thumbs up) or a bad day (thumbs down), to share their reasons, and a few students were asked to explain what they could do to improve or what the teacher could do to help them.

Compared to the Moscow school, the lack of a virtual learning environment hampered the Nizhny school use of online assessments. Nevertheless, the laptops have enriched a deep-seated cultural practice of monitoring student progress here as well. The Classmate PC's Classroom Management System has allowed teachers to incorporate a different kind of monitoring and assessment into their regular practices. Through this management system, teachers can broadcast quizzes and observe students' screens. Teachers can use the software to check student progress on a particular task, or to showcase an exemplary assignment. This allows for more personalization of learning. According to one 4th-grade teacher, "The ICT helps and the formative assessments help pay more attention to each child. I now have different tasks for each child's ability."

In the classes we observed at both schools, the online assessments were embedded within a larger pedagogical practice of a class-wide conversation about students' progress. Because students can see what their peers are doing, the management system encourages self-monitoring among students. Students can discuss the work immediately and can comment through the group chat function. They can compare their own progress on a task to that of their peers. They can learn from each other, share ideas, and build off each other's work. One of the high-school students explained an important difference of the assessments at this Moscow school: Unlike the rest of Russia, where there are just five letter grades (A, B, C, D, and E), their tests were in percentages and identified which items were wrong. He felt this was a much better way to know his strengths and weaknesses in each subject.

Communication with parents: Like many Russian schools (Alexander 2001; Elliott et al. 2001), both the schools have very involved parent communities. In the small town school outside of Nizhny, parents spoke with the teachers almost daily when they picked up their children from school. However, in Moscow, where traffic and congestion meant few parents could pick up their own children or find time to visit the teacher, the teachers spoke of using email and text messaging to maintain their link with the parents. The new e-record book was becoming a central link as well. Teachers post daily grades to the e-record book, but they also can post

messages to parents—either individually or to all the parents at once. The Moscow parents we interviewed checked the e-record book every few days, and especially if they wanted to see how a child had done on a big assignment or presentation.

The e-record book is playing a new role in building a parent community. The parents can communicate with each other through the e-record book. Parents in both Moscow and Nizhny spoke about using the e-record book to communicate with other parents. One father in Moscow who was very involved in the school, helping out on building projects like repairing the playground or painting, found the parent community feature of the e-record book to be a great advance in that he could easily coordinate with other parents to schedule activities. Instead of trying to track people down over the phone, he could coordinate simultaneously with a group of parents to assign tasks and pick dates. In Nizhny, parents have a school-wide parent organization on the e-record book platform with about 30–40 parents in the group, one representative from each classroom.

4.3.2.2 Student Technology Use

Almost every class we observed used the laptops to perform key tasks with students that would be impossible without the technology, and most of these key tasks fell into clear categories when used in the classroom. The ICT helps students do research, create presentations, and design projects.

Independent Research: In interviews, the teachers spoke of the potential of Internet research to give students a voice and allow them to bring information of their own into the class. Previously, the teachers and the textbooks were the only sources of information. One 4th-grade teacher in Nizhny talked about the changes in the student/teacher dynamic: "Now I help the children to find information for themselves, to guide conversations in the class, because there is so much information." Similarly, a Moscow elementary teacher reflected: "Now the children have many opportunities to find their own information; it makes them more active, provokes more thinking."

Access to laptops and computers and wireless Internet at school has also allowed students quicker and deeper access to information. One student in Nizhny talked about the Internet as a library that gives them access to many more books than they have access to in their physical school library. Another 10th-grader in Nizhny pointed out, "Internet research has helped us find more information than they could find in a conventional textbook."

Like many other adults we spoke to, one father connected children's access to information to broader social changes, reflecting on his youth in the Soviet era where "media was controlled and provided no real information," but today students can easily find information over the Internet, TV, and other media. He felt the school was both encouraging students to find their own information and giving them the skills to do it well.

However, teachers seldom used class time for Internet research because of the limits on the amount of time students may spend on the computer. When students did conduct research in class, teachers had other objectives. For example, a 6th-grade science teacher in Moscow, starting a unit on the evolution of plants,

had divided students into research groups and gave them 15 min to organize themselves and do preliminary Internet research to develop a work plan. After 15 min, the groups gave oral updates to the class about what their next steps would be.

Student Presentations: Gathering information, creating presentations, and facilitating presentations are common instructional practices and play an important role in the education of the students at both schools. Access to the Internet and to the Classmate PCs at school allows them to quickly find information to build a presentation during class or after school. Doing in-school presentations provides a number of benefits.

Through the creation of presentations, students are learning multimedia communication skills, creativity, and collaboration skills. Presentations provide an opportunity for teamwork and for children to learn how to work with others. Through presentations, students use text, image, and sound to make artistic choices and build an effective and a compelling product while improving their research analysis and oratory skills. In one 7th-grade Russian literature class in Nizhny, students presented complex PowerPoints with sound and multiple moving images that they had created about various aspects of Russian culture such as the various meanings and images of connected to word "motherland," or the impacts of industrialization on the Russian wilderness.

Finally, presenting to their peers and being able to assess peers' presentations creates a sense of competition that motivates students. Teachers observed how the competition pushes their students to create better presentations, provide more or novel information, and improve their public-speaking skills.

Creating Products: In Nizhny, students most often used the laptops to engage in the design and creation of real-world products. Students used productivity software such as word processing software and spreadsheets, along with other Web 2.0 tools such as Advance Graph, or Sticky Notes. Through these applications, students not only learned vital technical skills but also practiced more complex thinking skills such as designing, analyzing, collaborating, and presenting. In one after-school informatics class, the teacher used Intel's *Skills for Success* program to have 1st graders design a survey about travel. The students were also able to decide how they would graph the results using Excel (see footnote 1).

Collaboration: In all of the classes we observed in both schools, students were collaborating in some capacity for at least some part of the lesson—to deliver a presentation, conduct research, or complete in-class assignments. One 4th-grade teacher in Nizhny explained the changes in the levels of collaborations since the introduction of the computers. "The computer has helped very much to promote collaborative work. Children frequently use computers in their group work. They can share information, communicate with each other. In the past students sat in rows listening to the teacher, before they worked in pairs, but now they can work together anytime and anywhere."

Through the presentations, students can be sources of information and expertise for their peers; they have a responsibility to find good information and present it in a way that is clear and understandable. A 5th grader in Moscow explained how the different strengths and interests of team members would compliment each other to strengthen the team. He also felt that teamwork was building an important skill for the future, because "when you group up, you will work in teams."

In addition, students are learning collaboration skills that are relevant to life beyond the classroom. Students and teachers alike recognize the challenge of working in a group with individuals you don't like. But both groups noted the importance of learning how to work with others and of figuring out how to produce a high-quality product or project despite the differences.

4.4 Discussion

In our observations in the classrooms of the Moscow and Nizhny schools, we saw a number of teaching strategies that used the laptops, supported by other technologies, to engage students and support their learning in innovative and potentially powerful ways. In these classrooms, the use of the laptops was intertwined with an ecosystem of interactive whiteboards, the e-record book, online assessment, and wireless connectivity. Across both schools, the introduction of new ICT tools into the classrooms and of new learning activities at the schools is having an impact on what students do in the classroom and on their experiences at schools in a number of interesting ways. Computer use and access to key Web-based educational tools facilitated changes in three important practices (research, assessment, collaboration) that in turn supported changes in the overall learning environment including student engagement, classroom behavior, and social interactions.

4.4.1 Increased Independent Student Research

The teachers at both schools spoke about the importance of asking students to do their own research on the Internet. Teachers felt this was important for two reasons. First, because it gives students a new active role, making them responsible for their own learning. Second, especially in post-Soviet Russia, teachers felt it was important for students to understand that there are many sources of information and many perspectives. The Internet allows students to find information and select the best on their own. Independent research encourages students to pursue their own interests and interpretations of topics, which they can then share with their teachers and peers. The presentations that we saw, which were based on student research and perspective, allowed students to share and debate issues.

4.4.2 Increased Formative Assessment and Self-Reflection

Traditionally, Russian teachers frequently assess students' understanding with quizzes and tests, but the laptops, combined with virtual learning environments (Prometheus or the built-in LMS), allowed both schools to integrate easy, computer-supported assessment, and self-reflection into any lesson where the laptops are

available. These online assessments provide students and teachers immediate feedback about strengths and weaknesses. The way teachers wove assessment and self-reflection into lessons reinforces the traditional Russian pedagogic goals of student self-regulation and management of their own learning (Alexander 2001; Hufton and Elliott 2000). After the assessments, teachers asked students to reflect on the results and discuss what they could do to improve their scores the next time.

This formative self-assessment is potentially a very powerful practice, since the research from other countries on formative assessment shows a strong relationship to student learning (Black and William 1998; Hattie 2008); even student self-assessment (McMillan and Hearn 2008) and student self-reflection (Andrade and Valtcheva 2009; Hattie 2008) can improve learning outcomes. Not only does it enable teachers to know where students are in their learning, it encourages the development of students' meta-cognition as they assess where they are, realize what learning challenges they experience, and develop ways to improve.

4.4.3 Increased Student Collaboration

The introduction of laptops and access to wireless Internet allows students to work together at school or from home. The technology facilitates group research projects and presentations, and allows students to communicate freely. Students enjoyed the increased peer interaction even when they recognized the challenge of working with individuals with varying skill levels. One 4th-grade teacher described the changes she has seen: "Using computers brings the collaborative work into the classroom. In the past, students sat in rows listening to the teacher, before they worked in pairs, but now they can work together anytime and anywhere." The Intel Learn Skills for Success curriculum has also provided students with more opportunities to work together to solve problems and design projects.

The above three elements support transformations in four important aspects of the learning environment.

4.4.4 Increased Engagement Among Students

Through increased engagement with content outside of the classroom (i.e., Internet research), more time for self-reflection, and increased opportunities for peer interactions, Russian students in these two schools expressed more excitement about school and learning. Even though students were already quite engaged in school, they noted a number of benefits from having access to the technology. A 7th-grade student in Nizhny said, "I like studying with the ICT. We know we can use the knowledge we receive here in our future lives." The computers and Internet are helping them do things like tell stories, visualize texts, conduct deeper analysis, and find more information than they could find in a conventional textbook. Students also can create software programs in their informatics class.

Many of the parents interviewed talked about their children having an increased interest and engagement in school since the introduction of the laptops. A 4th-grade teacher in Nizhny remarked that she tries to make her classrooms more open by encouraging students to ask her questions. She went on to say, "Now, using the technology, kids start to help. In previous times, teachers told students to be quiet, but now we ask kids to debate and discuss."

4.4.5 Creating a More Personalized Learning Environment, Even with Whole-Class Instructional Formats

The research literature identifies an important variable for fostering children's engagement in learning—creating an environment in which they feel personally known (McLaughlin et al. 1990; Sebring et al. 1996; Wehlage 1989). The roles of the Russian students as researchers, as another source of knowledge, and as active participants presenting and debating information with peers, helps students know that they are seen by their teachers and fellow students as individual learners with unique perspectives. The ongoing assessment also supports personalization, because the teacher can monitor students' individual progress. This increased access to achievement data allows students and teachers alike to create more personalized lesson plans and activities. One of the informatics teachers summarized the changes: "The education process has changed. We are paying more attention to the individual children, and we do more projects."

Teachers at both schools spoke about the ways in which the immediate feedback provided by the electronic formative assessments helped them adjust their lessons and vary their assignments to meet the needs of individual students. In Moscow, a teacher talked about the value of the formative assessments: "[The e-learning platform] helps get education results and I am able to monitor the progress of each student. Teachers can help figure out the most appropriate intervention for each student. During teacher planning, I can adjust my lessons to help those students." In school in Nizhny, teachers used the Classroom Management Software built into the laptops to monitor student focus and progress. They encouraged students whom they saw falling behind, and gave more challenging work to students who were speeding ahead.

4.4.6 Changing the Relationship Between Students and Teachers

The new learning strategies enabled by the technology were giving students new roles in bringing in information and sharing knowledge. Access to the laptops and technology tools are being used for more student-directed research, more individualization of the design and presentation of projects, and more interaction and collaboration among peers. Students are more empowered to make choices about

their own learning. The changing classroom practices are, ultimately, shifting the relationship between Russian teachers and students. Though teachers continue to design and set the parameters for most of the learning activities, they no longer control every step.

The computers and the Internet increase student access to information, so the teacher is no longer the sole provider of answers. One 4th-grade teacher described the change in this way: "In the past, students did not have computers, their only source of information was the teacher. Now, the teacher is like a facilitator, a tutor that helps children to get information. Now students can search for information themselves." The increased access to information has empowered them to take more control of their own learning. Students' investment in their own education drives how they use the technology and facilitates their ability to know when they need to work harder and get extra help. Through the e-record book, students can find their grades and other records. With this tool they can immediately see where they are excelling and where they are struggling. Students who are not satisfied with their grades will seek out their teacher to get additional instruction to improve their grade.

Teachers also perceive that student relationships have changed as well. The informatics teacher in Nizhny agreed: "It was more rigid when I was a student. The environment of the classroom is more free, students are more free to ask questions to the teacher." Now that the students are asked to work in teams and to collaborate in projects, students are more apt to support each other around academic, social, and technical problems.

4.4.7 Facilitating School-Community Connections

Research suggests that Russian parents tend to be involved in monitoring and promoting their children's attention to school and schoolwork even through high school (Elliott et al. 2001; Hufton and Elliott 2000), but the technology has helped to enhance and improve the old practice by supporting parent–teacher communication. There is a seamless link between school and home, and communication is now quicker and more efficient. Because of the high level of technology access in homes, parents are able to stay abreast of their children's progress and can asynchronously communicate with teachers, rather than waiting for the monthly or yearly face-to-face meeting.

The e-record book, in particular, plays a key role helping parents stay informed of their children's progress and enabling communication with teachers and among parents. In accordance with Russian ideas of education, community is very important and both schools were using technology to support that dimension. In particular, in Moscow (where the complications of traffic and urban sprawl make it harder for parents to visit the school as frequently as in the past) the e-record book, email, and texting helped parents stay connected. Through the e-record book, parents in Moscow have more access to student progress and can be more involved in helping students reach maximum achievement level.

4.5 Conclusion

The initial impetus of this research was to look closely at schools and classrooms where technology is being used in context. Our exploration focuses on the experience of two Russian schools that are using the laptops daily. The impacts of these tools can be seen in classroom practice, student engagement, peer collaboration, assessment, and communication with parents. This, in turn, has shifted the dynamic between teachers and students and has also helped foster a more personalized and humanistic learning environment.

Although both Russian schools developed their own approaches to how to use the laptops, there are common elements supporting their success. First, the emerging ICT-rich practices are the result of careful instructional decisions being made at the school level. Both schools are taking advantage of external resources and training, but the actual classroom practices are supported by principals and are carefully tailored and embedded in the classroom by the teachers. Successful integration is a deliberate process, guided by strong principals and administrators working closely with their teachers, who together carefully move these new tools into their practice. The principal is able to set a vibrant and coherent school culture that welcomes innovation, while the teachers figure out how the device compliments their goals and lessons.

Second, the laptop by itself would not be an effective tool if it were not paired with the interactive whiteboards and the virtual learning environments. The core of both laptop programs is classroom sets of Intel Classmate PCs, interactive whiteboards or projectors, wireless Internet access, and a virtual learning environment. The success of each ICT tool is tightly linked to the others. This ecosystem of tools, coupled with specific teaching strategies, mediate the students' engagement with the content: (1) use of the virtual learning environment for collaboration, organizing, sharing and assessing, and monitoring progress; (2) use of the interactive whiteboard to support whole-class instructional approaches and student presentations; and (3) use of the e-record book to connect schools and parents.

Acknowledgments This research was funded by a grant from Intel®.

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Chapter 5
An Introduction to ICT in Education in China

Di Wu

Abstract ICT exerts revolutionary influence on the development of education. Most developed countries attach great importance to ICT in education and have worked out a series of national strategic plans to support and promote the development of ICT in education. China has also made a strategic choice to facilitate education modernization through ICT in education in its education reform and development. To date, China has achieved considerable progress in ICT infrastructure construction, application of digital resources, teaching innovation and ICT-supported educational management. However, there still exist problems in awareness, mechanisms, spending, and talent team construction. Since the "National Development Plan for ICT in Education (2011–2020)" was issued in 2012, the Ministry of Education of the People's Republic of China has taken a series of measures such as "three connections and two platforms," "full coverage of digital education resources in teaching sites" and "teacher training," adhering to the core idea of deep integration between ICT and education, and sticking to demand-driven application and mechanism innovation. This chapter focuses on the status, problems, targets, key measures, and experience of ICT in education in China.

5.1 Development Background of ICT in Education in China

5.1.1 Development Background of Education in China

China, as the second largest economy, is still a developing country in the world with a population of 1.3 billion, or about 21 % of the world's total. At present, about 310 million students are receiving education each year.

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R. Huang et al. (eds.), *ICT in Education in Global Context*,
Lecture Notes in Educational Technology, DOI: 10.1007/978-3-662-43927-2_5

Table 5.1 Number of students in different types of education

	Number of Students (in thousands)
Preschool education	36857.6
Primary education	96959.0
Junior secondary education	4763.06
Senior secondary education	45952.8
Undergraduate education and vocational education	23913.2
Master's degree education	1436.0
Doctoral degree education	283.8

Table 5.2 Targets of educational development in different types of education

	Targets of educational development
Preschool education	By 2020, 1-year preschool education will be provided for all the children, 2-year for most of them, and 3-year for children in developed communities. The 0–3-year old childhood development will be improved with great efforts
Compulsory education	By 2020, every school-age child will be guaranteed with access to good education by expanding the coverage of primary and junior secondary education (compulsory education), improving overall education quality, and balancing education development in a specific area
Senior secondary education	By 2020, senior secondary education will be developed in a vigorous way to meet the needs of junior secondary graduates for further education
Vocational education	By 2020, a well-structured vocational education system covering both secondary and post-secondary level will be constructed, in coordination with industrial restructuring and the change of economic development models. This will meet the social needs for a high-quality workforce and skilled personnel
Higher education	By 2020, higher education will be better structured and more characteristic. The overall level of talent quality, scientific research, and social service will be greatly improved. A number of high-quality and world-known universities will come to the fore, some of which will be in the world-class list

By the end of 2012, China's gross attendance rate (percentage of the total population in a given age group) was 64.5 % for preschool education, 99.9 % for primary school education (6–11 age group or 7–12 age group), 102.1 % for junior middle school education (12–14 age group), 85 % for senior middle school education (15–17 age group), and 30 % for higher education (18–22 age group).[1] The number of students in different types of education can be found in Table 5.1. Table 5.2[2] shows targets of educational development in different types of education.

[1] http://www.moe.gov.cn/publicfiles/business/htmlfiles/moe/moe_1485/201308/xxgk_155798.html.

[2] http://www.gov.cn/jrzg/2010-07/29/content_1667143.htm.

5.1.2 Development Background of ICT in Education

As an important part of national economy and social informatization, ICT in education aims at fully using ICT in all fields of the education system, developing and utilizing information resources, facilitating information exchange and knowledge sharing, and promoting educational modernization under the planning and organization of the central government and educational departments. ICT in education plays a significant role in promoting the balanced development of compulsory education, perfecting the life-long education system, achieving educational equity, improving education quality, and constructing a learning society.

Both developed and some developing countries attach great importance to ICT in education, which they consider to be an important strategy in improving quality of the whole people, enhancing innovation capacity, and strengthening national competitiveness. Planning of ICT in education in some countries proves to be highly effective and greatly promotes the development of education.

Facilitating educational modernization through ICT in education is a strategic decision of China in education reform and development. The report of the 18th National Congress of the Communist Party of China (NCCPC) clearly includes "the great increase of the level of informatization" in one of our goals in building a moderately prosperous society and points out that China will follow a path with Chinese characteristics of new industrialization, informatization, urbanization, and agricultural modernization. In addition, in CPC Central Committee's decision on major issues concerning comprehensively deepening reforms approved at the Third Plenary Session of 18th CPC Central Committee, specific requirements were listed concerning "energetically promoting equality in education" and "establishing effective mechanisms to expand the coverage of quality education resources through ICT and gradually narrowing the regional, rural-urban and inter-school gap." All of these decisions clearly show that CPC and the Chinese government lay great stress on informatization.

In addition, "National Medium and Long-term Plan for Education Reform and Development (2010–2020)" stated that "by 2020, China will have become a country with power of human resources in a learning society by building a powerful, vibrant, and modern education system, which can provide equal educational opportunities, quality education resources, and life-long education for every single citizen." The "Chinese Dream" cannot be realized without the support of informatization.

5.2 Status and Problems of ICT in Education in China

5.2.1 Status of ICT in Education in China

There has been a sustained increase in the total education input and national fiscal expenditure of education. The Report on the Work of the Government delivered at the 12th National People's Congress (NPC) in March 2013 clearly points out that

the Chinese government "gave high priority to developing education. Government spending on education totaled 7.79 trillion yuan over the past 5 years, increasing at an average annual rate of 21.58 % to reach 4 % of GDP in 2012. We allocated educational resources, giving priority to rural, remote, poor, and ethnic minority areas and made notable progress in improving fairness in education."[3]

In recent years, the Ministry of Education of the People's Republic of China issued a series of important plans including "The Tenth Five-year Plan of ICT in Education,"[4] "The Action Plan for Invigorating Education in the 21st Century,"[5] "The Action Plan for Invigorating Education (2003–2007)",[6] "National Medium and Long-term Plan for Education Reform and Development (2010–2020)"[7] (hereinafter referred to as "the Plan") and "National Development Plan for ICT in Education (2011–2020)"[8] (hereinafter referred to as "the Plan for ICT in Education"), which provides strong support for the construction of ICT in education and contributes to notable progress of ICT in education in China.

5.2.1.1 Infrastructure Construction

Currently, China Education and Research Network (CERNET) and China Education Broadband Satellite Net (CEBSat) together with education networks of some provinces are interconnected with public networks, forming an education information backbone network that covers the whole country and "connects the sky and the ground." CERNET, connecting over 2,000 education and research institutes and serving over 20 million users, has become the biggest national-level academic network worldwide. A new generation of national Internet backbone network undertaken by approximately 100 universities becomes the largest Ipv6 experimental network in the world. It breaks the bottleneck of Internet address resources and expands the space for long-term development of ICT in education. College campus network (CN) has been highly popularized. Many primary, middle, and high schools have gained access to CN. The majority of rural primary, middle, and high schools have been equipped with information terminal devices. The ratio of students to computers in elementary education has changed from 19:1 in 2008 to 13:1 in 2011 in all schools with elementary education having gained access to the Internet.[9] Over 1.6 million multi-media classrooms have been built in compulsory education schools, accounting for 41 % of all classrooms. Schools equipped with no less than one multi-media classroom reached 50 %. And the web-based teaching and learning environment has been gradually improved.

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[3] http://news.xinhuanet.com/english/china/2013-03/18/c_132242798.htm.

[4] http://www.moe.gov.cn/publicfiles/business/htmlfiles/moe/s3341/201001/xxgk_82366.html.

[5] http://www.moe.gov.cn/publicfiles/business/htmlfiles/moe/s6986/200407/2487.html.

[6] http://news.xinhuanet.com/zhengfu/2004-03/31/content_1393111.htm.

[7] http://www.moe.edu.cn/publicfiles/business/htmlfiles/moe/moe_177/201008/93785.html.

[8] http://www.moe.gov.cn/publicfiles/business/htmlfiles/moe/s3342/201203/xxgk_133322.html.

[9] http://www.moe.gov.cn/publicfiles/business/htmlfiles/moe/s3342/201211/xxgk_144240.html.

5.2.1.2 Application of Digital Resources

A system of digital education resources covering all levels and types of education has already taken shape, which facilitates the innovation of education concepts and methods. In compulsory education, China has built a resource pool with nearly 15,000 class hours of video education resources provided for free to 160 million students in all rural primary, middle, and high schools. In vocational education, information resource networks are offered to facilitate resource collection and sharing. In addition, 400 national quality courses of higher vocational education are updated. In higher education, the majority of universities have built teaching resource pools with 1,800 libraries sharing the service and more than 3,800 national public video courses offered free of charge for the whole society. Different types of schools in different areas also offer public video courses online. Distance education is applied in the training of rural migrant workers, cadres, and employers in some enterprises. So far, tens of millions of people have received degree and nondegree education through online courses. The construction of quality public video courses has started since 2011. By January 2013, visits to the home page of "video courses of Chinese universities" on "icourse," CNTV, and Netease totaled 3,862 billion with a total of 35,693,200 visits to all video courses. The national education resource public service platform is now able to serve 11 million teachers and students, and there are now more than 6 million real-name cyber learning spaces.

5.2.1.3 ICT-Supported Educational Management

ICT is applied to many aspects such as teaching, management, and research, thus improving the methods of educational management and increasing working efficiency and service quality. The national ICT platform for education examination enrollment and security supervision is established to serve enrollment in college entrance examination and senior high-school entrance examination that involves tens of millions of students every year, and it has become the key support for the enrollment of the "Sunshine Project." The school building information management system provides anti-seismic and consolidation information of nearly 2.12 million buildings in 410,000 schools and teaching sites. A national network of school building information management system was built the moment the school building safety project was launched, which effectively facilitates the implementation and management of the school building safety project. The ICT platform of college roll management and education certification not only serves students and the society but also contains the undesirable phenomenon of fake diplomas. The enrollment system now covers more than 85 % of all students and allocates one number for each student. The college employment information platform produces employment files for all graduates and it has become an indispensible supporting platform in work related to students' employment. Moreover, we use information technology to explore

the interaction between parents and the school to guarantee timely communication between teachers and parents and to handle the safety issues of students in primary, middle, and high schools.

5.2.1.4 Increasingly Stronger Support for ICT in Education in Central and Western Regions

The Chinese government lays stress on ICT in schools of central and western China and rural areas, providing them with preferential policies and stronger support. The Ministry of Finance, National Development and Reform Commission, Ministry of Education and Ministry of Science and Technology have carried out the construction of campus networks in universities in the West and the project of modern distance education in middle and primary schools in rural areas. ICT infrastructure of different levels has been constructed as well. Since 2010, the central government has allocated 3.26 billion RMB as special funds to build around 200,000 multi-media classrooms in rural schools lacking in such facilities in central and western regions of China. In partner assistance, many provinces in central and eastern China pay great attention to the assistance of multimedia classrooms and quality education resources in middle and primary schools, which narrows the regional and urban–rural "digital gap" to a certain extent.

5.2.1.5 Construction of Talent Team

The cultivation of ICT talents and ICT application training moves forward smoothly in China. At present, students majoring in IT-related specialities reach about 3 million in all universities in China and another 5 million students majoring in these specialities can be found in vocational schools. In recent years, central and local governments have offered ICT training to over 5.5 million primary, middle, and high school teachers. In 2010, distance training programs were added to the national training program and 2.7 million primary, middle, and high school teachers received IT-aided subject training. Teachers' capability in using ICT has generally been enhanced. ICT education has been popularized in most schools with elementary education. All high schools, 95 % middle schools, and 50 % primary schools have set up ICT compulsory courses.

Generally speaking, work related to ICT in education has achieved remarkable progress. Especially since the Plan was issued, the significance of ICT in education has been universally acknowledged. There gradually form favorable policies, input guarantee system, and social environment which can facilitate faster development of ICT in education. Pilot projects of ICT in education are launched. Schools in different regions are further motivated. All of these pave the way for future work.

Table 5.3 An overview of the status of ICT in different types of education

Types of education	Status of ICT in education	Key words in development
Elementary education	Weak infrastructure, low level of information sharing and co-construction, imbalanced regional development	Balance, equity
Vocational education	Lack of practical teaching resources, low level of connection between vocational education and industries, broadband network connection has not been realized in all schools	Practical training, connection
Higher education	Infrastructure and resources have reached a certain level, but the quality and level of application are to be improved	High quality, integration
Continuing education	Network education has been initiated, but resource accumulation is inadequate. Open universities have not taken shape	Individuality, flexibility

5.2.2 Problems of ICT in Education in China

The problems of China's ICT in education should be approached from various aspects including the status of ICT in different types and levels of education, the overall development of ICT in education, and the implementation of work related to ICT (Planning panel, 2012).

Table 5.3 shows the status of ICT in different types and levels of education. As can be seen from the table, since the status and objectives of elementary education, vocational education, higher education, and continuing education are different, their ICT development goals and focuses are different accordingly. For example, the main target of elementary education is to achieve equity and balance, while for higher education, the focus is to achieve quality education as well as to promote innovation and deep integration of technology and education.

By analyzing the development of common factors of ICT in education, we can get the results presented in Table 5.4. As can be seen from the table, similar to "highway," "vehicle and freight," "supervision and management," and "maintenance" in the education information highway, respectively, infrastructure, resources, and application and ICT-supported management are all confronted with problems to varying degrees. For instance, the level of infrastructure is imbalanced in different regions, so ICT infrastructure needs to be further popularized, areas lacking in such facilities need to be equipped with ICT infrastructure, and ICT equipment in comparatively advanced regions needs to be improved. In terms of the supporting system, there is a lack of effective funding input mechanism. Relevant standards are not well implemented.

Table 5.5 shows the problems in the implementation of work related to ICT in education. It can be seen that the development of ICT in education is related to

Table 5.4 Development of common factors of ICT in education

ICT factors	Status	Key words in development
Infrastructure	The Sky-ground network has taken shape. Interconnection is not realized. Broadband network needs to be popularized	Availability, coverage, performance improvement
Resources and application	There has been a certain amount of resources but both the quantity and quality need to be improved. The mechanism for co-construction and sharing needs to be constructed	Availability, usability, user-friendliness
ICT-supported management	There are many individual operation systems. All operation systems have not been fully covered. The problem of information isolated islands is prominent	Individual application, sharing of data, process reengineering
Supporting system	The organizational system is not clear enough. The capital investment mechanism has not taken shape. Relevant standards and regulations are not well implemented	Rationalize mechanisms, ensure input, standardize development

Table 5.5 Problems in the work related to ICT in education in China

Problems	Description
Problems of awareness	Though the Plan has pointed out that ICT has revolutionary impact on education development, there is still a lack of awareness and clear understanding of the importance of ICT in education
Problems of mechanisms	The policy implementation and management mechanism needs to be perfected. The division between rights and obligations needs further clarification. The mechanism for multi-participation has not taken shape
Problems of spending	The total input is inadequate. A sustained and long-term input mechanism is needed. The use of spending is not appropriate enough because the problem of "preference of hardware to software" prevails
Problems of personnel	There is a lack of full-time staff. Issues related to staffing, evaluation, and employment, etc., need to be further specified. A system of personnel training and service needs to be constructed

guiding principles and management mechanisms about the integration of teaching, research, and management. Moreover, engineering factors such as spending and staff also play a role in the work. Therefore, all these factors should be taken into consideration in the planning of ICT in education.

5.3 Development Planning of ICT in Education in China

5.3.1 Planning of ICT in Education

Both CPC and the central government attach great importance to ICT in education. It is stated in the "National Medium and Long-term Plan for Education Reform and Development (2010–2020)" that "ICT exerts revolutionary influence

on education development, and thus should be attached great importance to," and that China should "speed up the development of ICT in education." One chapter in "the Plan" is dedicated to the overall planning of ICT in education with regard to infrastructure, resources and application, and ICT-supported management. In addition, "the construction of ICT in education" is listed among the ten key projects in "the Plan," which dramatically raises the strategic position of ICT in education.

China has issued "the Plan for ICT in Education" in March 2012 so as to cope with the fierce international competition in the integrated development of ICT and education, satisfy the demands of education reform and development in China, and meet the requirements about ICT in education in "the Plan." "The Plan for ICT in Education" introduces the major issues and development strategies that need to be supported by ICT in different types and levels of education.

5.3.2 Objectives of ICT in Education

In order to achieve the goals of ICT in education for 2020, "the Plan for ICT in Education" divides the medium and long-term development tasks into two stages. The main task in the first stage is to advance a series of important jobs in the hope of solving the major problems in ICT in education and establishing a system compatible with the development objectives of educational modernization by 2015. The focus of the second stage from 2016 to 2020 is to consolidate and enhance the construction completed in the previous stage and to specify the work priority of each link and the direction of sustainable development based on the progress of the action plan, the actual demands of education reform, and the development and status of ICT in education.

The 10-year development targets set in "the Plan for ICT in Education" are as follows, "to build an ICT-supported learning environment where all can enjoy quality education resources, to form an ICT-supported service system in the learning society, to achieve broadband network connection in all schools in all regions, and to greatly improve the level of ICT-supported education management and the integrated development of ICT and education."

First, from a macro perspective, we strive to reach the stage of comprehensive integration and innovation of ICT in education and build an education information system compatible with the objectives of educational modernization by 2020. The overall objective of China's ICT in education in 2020 is to get close to the international advanced level.

Second, regarding the key factors of ICT in education, we try to achieve progress in five major aspects by 2020, as shown in Fig. 5.1. Concerning educational ICT infrastructure, we try to connect all schools with broadband network and equip them with ICT learning terminals. As for the construction of education resources, the quantity of resources should be significantly increased and the quality should be greatly improved. In terms of the application of ICT in education,

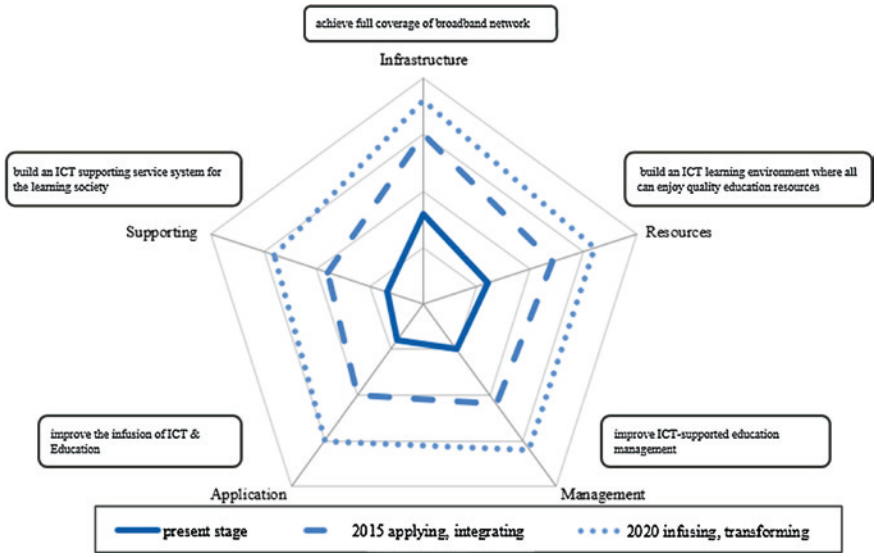

Fig. 5.1 Macro-development targets of ICT in education in China

Table 5.6 Development tasks of ICT in different types of education

Types of education	Development tasks of ICT in education
Elementary education	Narrow the digital gap in elementary education and facilitate the sharing of quality digital resources
Vocational education	Accelerate the development of ICT in vocational education and support the cultivation of high quality skilled talents
Higher education	Promote the deep integration of ICT and higher education and perfect the mode of talents cultivation
Continuing education	Build continuing education public service platform and perfect lifelong education system

ICT will be deeply integrated with teaching activities and teachers' ICT-supported teaching abilities should be notably enhanced. In ICT-supported education management, all major links will be ICT-supported and some procedures will be optimized and reconstructed. Finally, the management mechanism of the supporting system of ICT in education will get more mature and there will be innovation in the operation mechanism.

Finally, as to the actual development demands of all types and levels of education, the tasks in different stages vary due to different status and education objectives. For instance, the focus of elementary education is to narrow the digital gap and facilitate the sharing of quality digital resources; as for higher education, the priority is to improve the mode of talents cultivation, as can be seen in Table 5.6.

5.4 Key Measures of ICT in Education in China

5.4.1 Connecting Schools Through Broadband Network

"Connecting schools through broadband network" aims at providing every school with broadband access conditions and hardware and software facilities so as to create a basic ICT teaching environment. So the task entails two conditions. First, all types of schools at all levels should be equipped with the basic conditions for broadband connection. Second, the construction of the basic environment for web-based teaching should be completed. From the perspective of construction, two tasks are to be completed, namely the construction of the broadband access conditions and the basic web-based teaching environment in schools. In other words, schools should have multimedia classrooms with access to the Internet. Teachers should be provided with a set of basic software tools and teaching resources. A certain proportion of teachers need to get access to computers and they should be capable of preparing and teaching lessons with online teaching resources after training (Figs. 5.2, 5.3).[10]

In 2013, the work of getting rural compulsory education schools connected through broadband network has achieved the following progress: about 100,000 rural schools for compulsory education got connected with broadband network through various ways such as cooperation with state-owned telecommunication enterprises. Schools with access to broadband network reached 50 % of all. During implementation of "the improvement plan for weak rural compulsory education schools," schools lacking in ICT infrastructure got equipped with relevant facilities. In schools with access to broadband internet, web-based teaching environment was built as well. The goals of connecting all vocational schools with broadband network are as follows: try to get more than 80 % vocational schools connected with the Internet through various ways. Construct ubiquitous and safe broadband network infrastructure. Popularize the use of individual learning terminals among teachers and students, and encourage the use of ICT environment such as multimedia classrooms. Set digital campus construction standard in vocational education and strive to build standard digital campus in over 50 % vocational schools around the country.[11]

5.4.2 Connecting Classrooms with Quality Learning Resources

The goal of "connecting classrooms with quality learning resources" is to encourage teachers and schools with basic Internet access to use ICT actively and to make ICT-supported quality education resource sharing a regular part of teaching and

[10] http://www.ict.edu.cn/laws/jianghua/n20130513_4337.shtml.

[11] http://www.ict.edu.cn/news/n2/n20130424_4165.shtml.

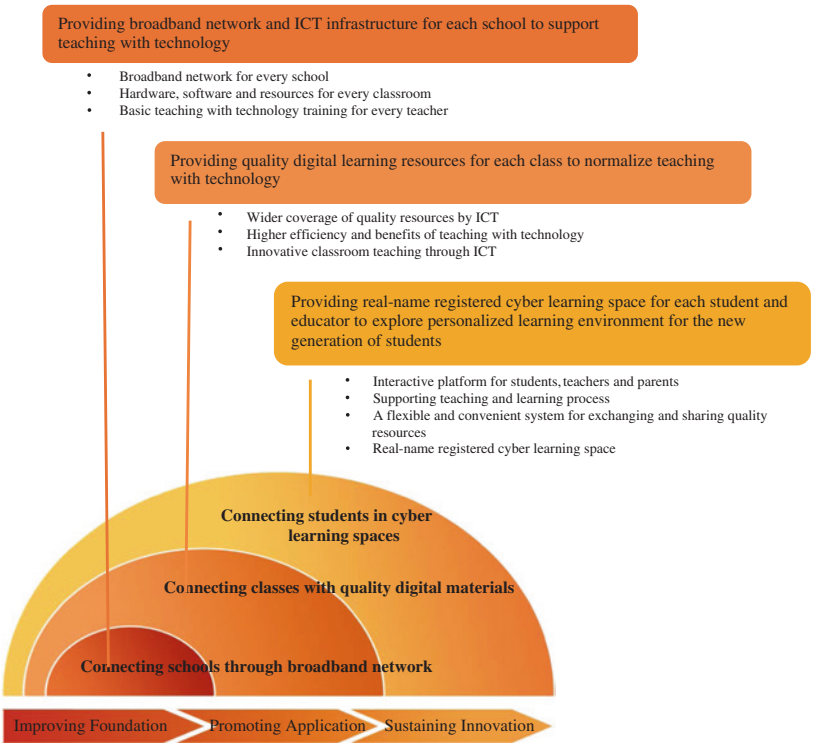

Fig. 5.2 Targets of Connect-SCS

Fig. 5.3 Digital classroom

research activities. The construction of rich and diversified quality digital education resources will have reaped first fruits by 2015, and the resources will be transmitted to all classes. The models to promote the sharing of quality education resources include "Distance class," "classes delivered by excellent teachers," and "online classes of prestigious universities." Through real-time online classes in "Distance class," students in remote rural schools where classes cannot meet the national standard of quantity and quality can attend the same class as students in schools in downtown areas where teaching resources are rather rich, thus promoting the sharing of quality teaching resources and improving teaching quality. In "classes delivered by excellent teachers," masters or well-known teachers are invited to deliver online courses to provide more and better quality education resources and to facilitate widespread sharing of resources provided by good teachers. "Online classes of prestigious universities" are intended to spread the rich teaching resources of prestigious universities to benefit more students through online classes.

The application of quality digital education resources covers above 50 % of all compulsory education schools. Teachers' teaching abilities and the teaching quality in rural primary, middle, and high schools are effectively improved. Furthermore, the construction of the authentication system for vocational teaching resources is strengthened. We also select 400 online courses and 50 sets of virtual simulation systems that cover all 19 categories of specialities in vocational schools from the public. The courses and systems are shared on the public service platform of national education resources; in higher education, we carry on the construction of open quality video courses.

5.4.3 Connecting Students in Cyber Learning Spaces

The first step to create "cyber learning spaces" is to build a web-based social platform that serves teachers, students, and parents and aims at improving teachers' quality and teaching quality to support teachers' online teaching and research activities, and the interaction between teachers, students, and students' parents. Second, there should be a service platform on which teachers can efficiently improve their capability in using ICT. The platform can recommend resources automatically to teachers so that they can effectively obtain proper resources through the learning space. The user-friendly development tools on the platform can help improve teachers' ability in developing teaching resources independently. Moreover, the platform should be able to collect quality resources. Namely, the platform can serve as a "resource supermarket" to make efficient resource transactions possible for different resource providers so that teachers and students can obtain richer quality resources. Finally, the platform should be capable of managing the learning spaces. Through the organization space of the platform, schools and education administration departments can manage all teachers and students' spaces, figure out how frequently and effectively teachers use the online resources to conduct teaching, get the quantity of courseware resources created by teachers

Fig. 5.4 Sharing quality resources

themselves, evaluate teachers' teaching activities and their ICT application, conduct statistical analysis of students' learning progress, and provide technical support for school or regional education administration departments in organizing online teaching activities (Fig. 5.4).

Regarding the construction of real-name online learning spaces in 2013, we have explored effective mechanisms for constructing online learning spaces, promoted in particular the construction of online organization spaces and teachers' spaces in primary, middle, and high schools and secondary vocational schools, and facilitated the construction of students' learning spaces. The number of online learning spaces reached 6 million among which 1.3 million online learning spaces were constructed with the support of a national education resource public service platform, 3 million were constructed on the national university informatization supporting platform, and the other 1.7 million were built on other platforms.

5.4.4 Education Resource Public Service Platform

"Education resource public service platform" directly affects the connection between collection, sharing, construction, and use of education resources. As a matter of fact, to construct an "education resource public service platform" is to construct a cloud service system. The cloud computing system can be used to facilitate the maximum and intensive sharing of software and hardware resources, and to reduce the cost and difficulty of ICT construction in schools; meanwhile, we promote positive interaction between the construction and use of education resources and strive to improve the application level. National "education resource public service platform" should be an interconnected cloud service system supported by cloud computing technology, covering the whole country and distributed at different levels so that it can provide technical support and online service to

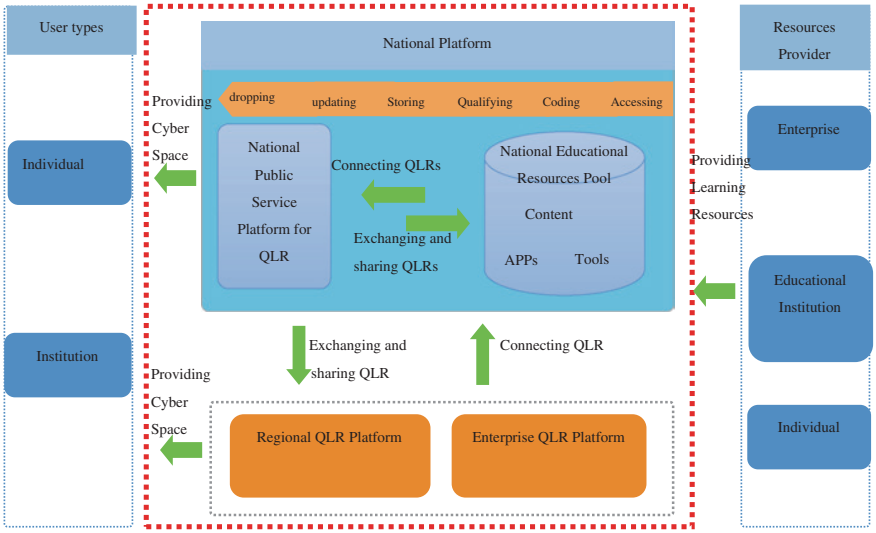

Fig. 5.5 Framework of National Public Services for Educational Resources

make quality resources accessible to all classes and online learning spaces available to all users.

With regard to the improvement and large-scale application of the national education resource public service platform in 2013, the following work has been accomplished: we have expanded the storage and service capacity of the national education resource public service platform, enriched resource information of all levels and types of education, improved the functions of the national education resource public service platform to enable it to provide online learning spaces and digital education resource service to 10,000 schools, one million teachers, and 10 million students, vigorously advanced the large-scale application pilots of the national education resource public service platform, opened online learning spaces for 300,000 teachers and 1 million students, improved teachers' ability in teaching and research, perfected teachers and students' teaching and learning methods, and improved teaching quality through the learning spaces (Fig. 5.5).

5.4.5 Education Management Public Service Platform

The plan for the construction of the national education management public service platform is as follows: according to the basic idea of constructing the educational data management system in national and provincial level for the application in national, provincial, prefectural, county-level, and in schools, we construct a management information system covering students, teachers, school assets, and

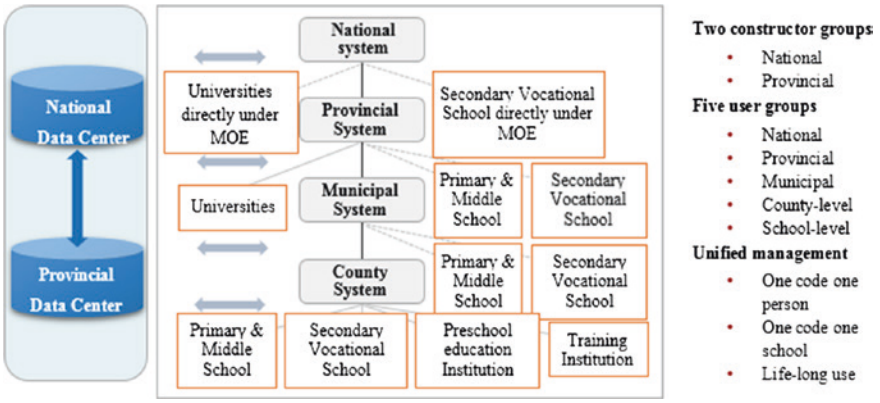

Fig. 5.6 Framework of National Public Service Platform for Educational Management

conditions of all levels and types of education, establish the national education management public service platform, open national education management gateways, and provide supervision and support for national key projects. We have completed the construction of central education data on the national and provincial levels and created an application environment where data are concentrated and systems are integrated; we build a management information system of all students and teachers nationwide and achieve national network connection of the system; a database with the basic data of all education institutions and some students and teachers has already taken shape and started to provide supporting service to educational supervision, decision-making and public service; we build application and operation maintenance systems that cover all levels of education administrative departments and schools, offer training to the technical backbone of the staff in basic education departments and schools to guarantee the long-term smooth operation and timely update of the systems (Fig. 5.6).

5.4.6 Full Coverage of Digital Education Resources in Teaching Sites

The tasks of making digital education resources accessible to all teaching sites are as follows: equip all teaching sites to be reserved or restored in the layout adjustment of rural compulsory education schools with digital education resource receiving and broadcasting facilities, send them quality digital resources, give full play to the central schools in every county, and encourage teaching sites to conduct teaching activities with digital resources. With the aid of ICT, we help all teaching sites to offer national compulsory courses, improve teaching quality, facilitate balanced development of compulsory education and provide for children of school age in rural and remote areas with good education in their neighboring

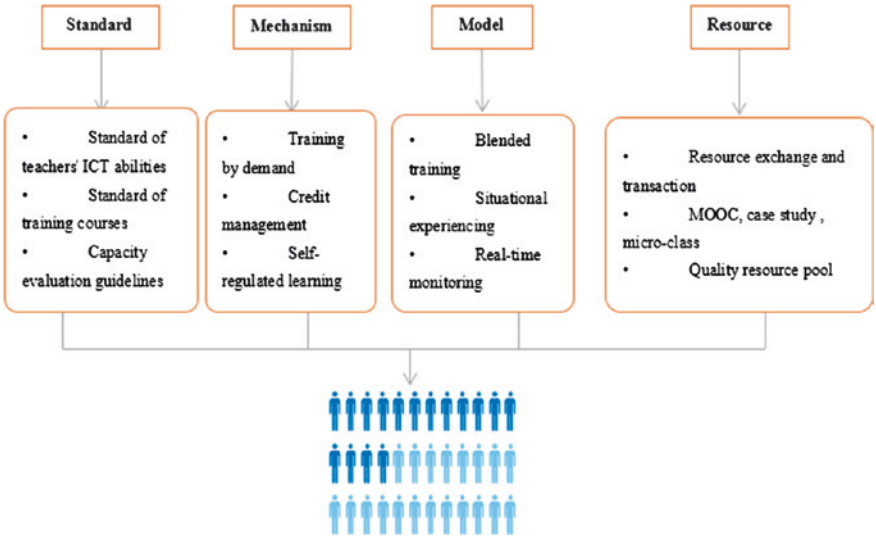

Fig. 5.7 Teacher training system

areas. To be specific, the task is to "equip all teaching sites with basic hardware facilities that can be used to receive digital education resources and to conduct teaching activities, and send digital education resources to each teaching site through satellite. For regions with needed equipment, the central government can further increase input to improve the facilities and the application of resources."[12]

5.4.7 Teacher Training

The construction of the teaching staff ensures the sustainable development of ICT in education. The ability to apply ICT is one of the essential capabilities of teachers in the information society. Thorough application of ICT in education calls for such abilities on the teachers' part. The capability to use ICT should be listed as one of the basic requirements for teachers. An important part of teacher training is to inform them of theories, methods, and cases of improving teaching methods and quality and advancing teaching reform with the aid of ICT. In order to enhance teachers' ability in using ICT, the Ministry of Education has carried out large-scale and ongoing training for all primary, middle, and high school teachers. It is hoped that a new round of training for over 10 million primary, middle, and high school (kindergarten included) teachers will have been finished by the end of 2017 (Fig. 5.7).

[12] http://www.moe.gov.cn/publicfiles/business/htmlfiles/moe/s3342/201211/xxgk_144800.html.

In 2013, the major tasks in teacher training on ICT application are as follows: carry out special ICT training for teachers in primary, middle, and high schools. With the purpose of facilitating deep integration between ICT and teaching, the training mainly focused on improving teaching methods, promoting teaching reform, and improving teaching quality through ICT. Over one million middle and primary school teachers were trained through various ways, which improved their ICT capability and literacy.

5.5 Experience of ICT in Education in China

The Chinese government has taken ICT in education as the decisive strategy for educational reform and innovation and has gained valuable experience in infusing ICT in education by connecting schools through broadband network, connecting classes with quality digital learning resources, and connecting students in cyber learning space.

5.5.1 Adhering to the Core Idea of Infusing ICT into Education

ICT brings new ideas and driving forces to the development of education, which profoundly transforms the educational content, methods, and modes. This transformation goes with a process of mutual influence and promotion between ICT innovation and education development in the knowledge society, which is recognized as the essence and objective of ICT in education by the Chinese government.

Integrate ICT with education development. The value of ICT in education can be seen only when ICT is integrated with education by changing traditional education ideology and models, and by developing new teaching methods and patterns.

Quality education drives ICT innovation. The reform of education and the innovation of educational ideas require the support of advanced ICT, which promotes ICT development.

5.5.2 Adhering to the Basic Principle of Demand-Driven Application

First, take application as the pick-up point and focus of construction, which also drives the construction of ICT infrastructure and facilities. Second, focus on integrating ICT into classroom learning activities and the effectiveness of ICT in education. Third, promote the infusion of ICT into the whole instruction process and all subjects. Fourth, normalize the use of ICT in daily teaching activities. Finally, evaluate teachers' ability in using ICT applications through teachers' qualification system.

5.5.3 Adhering to the Fundamental Policy of Mechanism Innovation

Motivate all sectors of society and bring the advantages of market-allocated resources and professional service provided by enterprises and other institutions into full play, so as to realize the role of development in promoting ICT in education.

Investigate a number of model schools, key teachers and quality courses through experiment, explore innovative, and effective teaching models in different ICT conditions and accumulate typical experience for wider promotion.

5.5.4 Supporting Students, Teachers, and Administrators with Connect-SCS as Critical Approach

Connect schools through broadband network. ICT helps to improve the teaching conditions in underdeveloped areas, narrows the digital divide, and promotes educational equity so as to lay the foundation for the development of ICT in education.

Connect classrooms with quality learning resources. It triggers the reform of traditional teaching and learning, advances the full infusion of ICT into education, and promotes teachers' capability and awareness of applying ICT so as to effectively elevate the quality of education.

Connect teachers and students in cyber learning spaces. It expands the space of education, provides support for fostering students' twenty-first century skills, deeply plants the idea of promoting educational reform through ICT in people's mind, and facilitates the innovation of teaching and learning.

5.5.5 Advancing Educational Administration with ICT-Based Management

Create life-long e-portfolio for all students. Establish a life-long e-portfolio for each student by promoting "one code one person" to effectively elevate the service level for learning and advance the innovation of evaluation methods for learning.

Establish teacher development e-portfolio system. Build teacher development portfolio and integrate the process of pre-service learning, in-service learning, working, and training so as to promote their teaching capabilities and professional development.

Construct public service platform and decision support system for educational administration. The establishment of public service platform and decision support system for educational administration makes it possible to get accurate real-time

information about students, teachers, school buildings, and other affairs for educational administration. The decision analysis system via data mining and analysis significantly improves the process of educational administration and decision-making, and provides educational public services for stakeholders.

5.6 Conclusion

Between now and 2020, under the favorable conditions brought by the issuing of "National Development Plan for ICT in Education (2011–2020)," ICT in education in China is bound to make significant breakthroughs. In the foreseeable future, the effect of ICT on educational development will be clearly demonstrated; the overall level of ICT in education in China will be greatly improved; the integration between ICT and education will gradually go deeper and ICT in education will keep promoting education reform and innovation in China.

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Chapter 6
Sustaining and Scaling Research-Based ICT in Education Innovations in Singapore

Chee-Kit Looi and Wenting Xie

Abstract The conceptualization and implementation of the third Masterplan of ICT in Education (MP3) in Singapore provides a microcosm of the challenges and strategies for mainstreaming and scaling good practices in technology-enabled learning. A key component of MP3 is research-based educational innovations. In this paper, two succinct examples of such innovations adopting the design-based research approach that have shown promises of impact on classroom practices, on student learning, and of being able to be sustained and scaled to broader contexts of use are elaborated and discussed. Basing on the reflective accounts, the affordances of design-based research for sustaining and scaling innovations are summarized. The conditions for adoptability and adaptability of education innovations by schools and teachers are also identified.

Keywords Design-based research · Collaborative learning · Mobile learning · Innovation scaling

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R. Huang et al. (eds.), *ICT in Education in Global Context*,
Lecture Notes in Educational Technology, DOI: 10.1007/978-3-662-43927-2_6

6.1 Introduction

With the realization of the immense potential of technology to enable transformation and improvement in learning, an increasing number of countries and regions have invested in funded research on technology-enhanced learning. Many of these research projects focused on establishing the efficacy of the designed innovations that work within specific contexts. They typically face the conundrum of narrowing the research-practice gap when it comes to innovating or transforming practices in schools and other contexts of learning, and to scaling up to meet the needs of a broader audience. Such research projects are also typically not organized so as to address the challenge of long-term improvement.

"Decades of funded study that have resulted in many exciting programs and advances have not resulted in pervasive, accepted, sustainable, large-scale improvements in classroom practice, in a critical mass of effective models for educational improvement" (Sabelli and Dede 2001). To address the situation, collaboration among the policymakers, practitioners, and researchers needs to be pursued to enhance the sustainability and scalability of research-based innovations to inspire systemic change. In the educational ecology established in Singapore, the synergy of national policy, school practices, and research is one that is much desired and sought after. Within the ecology, a combination of strong, explicit top-down directives and pockets of bottom-up desire and initiatives for transforming and improving the educational system coexist. Thus, educational reforms are being actualized in a spectrum that spans many critical dimensions: from exacting top-down policy imperatives to encouraging ground-up efforts, from translating research to impacting school practice, from implementing one classroom intervention to scaling for more successes, from mere usage to effecting cultural and epistemological shifts of the stakeholders, and from experimenting with technology to providing robust national or district technology infrastructures or seeding commercial ideas for industry.

In this chapter, the focus is on demonstrating how the efforts made at the macro-level (education policies set up by policymakers), meso-level (researchers interpreting and studying education policies and their interpretation), and microlevel (practitioners implementing practices vis-a-vis or despite education policy imperatives) are communicated and coordinated to sustain and scale educational innovations so as to pave the way for reform in the educational context of Singapore. The conceptualization and implementation of the third Masterplan (MP3) of ICT in education is presented as the macro-level context in which innovations in school-based learning are encouraged and supported. Research-based ICT innovations in education provide one of the mechanisms that mediate between the macro-level agents and the micro-level agents to empower change. Researchers can interprete broad policy imperatives, do implementation research with schools to understand and address some of their teaching and learning problems, and thereby co-create innovations building on the best practices in the literature. To elucidate this, two succinct case studies in research innovations which

have shown promises of impact on classroom teaching and learning, and potential of being sustained and scaled to a broader range of contexts of use, are described. Drawing on these case studies, the conditions that can inform the sustaining and scaling of educational innovations are distilled and elaborated.

6.2 The Third Masterplan of ICT in Education in Singapore

Singapore is a small city-state with a population of 5.4 million people (Department of Statistics Singapore 2013). Its education system is generally well received for its high quality (Schwab 2012). To maintain and further improve its education (especially in preparing students for the challenges and opportunities in the twenty-first century), the government has launched three Masterplans for ICT in Education as concerted efforts to drive the use of ICT to enrich teaching and learning in Singapore schools since 1997 (Ministry of Education 2008). A division under the Ministry of Education (MOE) has been set up as a focal point to drive the conceptualization and implementation of the Masterplans.

6.2.1 Goals and Strategies of MP3

MP3 is positioned as the continuation of the first two masterplans which focused on "building the foundation" and "seeding innovation" respectively. Working toward the vision of "Harnessing ICT for Future Learning," MOE has set four specific goals for MP3, which include: (1) students possess competencies for self-directed learning (SDL) and collaborative learning (CoL) through the effective use of ICT as well as become discerning and responsible ICT users; (2) Teachers have the capacity to plan and deliver ICT-enriched learning experiences for students to become self-directed and collaborative learners as well as nurture students to become discerning and responsible ICT users; (3) school leaders provide the direction and create the conditions to harness ICT for teaching and learning; and (4) ICT infrastructure that supports teaching and learning anywhere, anytime.

Building on the infrastructures and innovations attained in MP1 and MP2, MP3 is devoted to "strengthening and scaling" the effective innovations enabled by ICTs to cultivate self-directed and collaborative learners who can thrive in the twenty-first century (MOE 2009). It is expected that as the implementation of MP3 proceeds, there will be strengthening, sustaining, and scaling in the use of ICTs to achieve transformation and improvement in learning. This can be distilled from the shift in teachers' epistemological orientations from being transmissionist to constructivist and norms of classroom interaction from didactic to dialogic (e.g., Looi et al. 2011b). The use of ICT will be sustained over time despite the change of teachers, principals, and the curriculum, to retain the core elements

of innovation. The use of ICT for effective pedagogies will be scaled through spreading and diffusing good pedagogical practices across subjects, grade levels, and schools; and to collectively adapt and enable evolution through participatory efforts of multiple agents in the ecosystem to improve the innovation.

To achieve the goal of sustaining and scaling innovations, substantial government support including a significant level of financial investment and a complex and rich array of measures (targeted at different levels of the education system such as the school principals, department heads, teachers, and teacher educators, etc., and the whole educational ecology including the industry and other service providers) is provided. The broad strategies of MP3 adopted include: (1) to strength integration of ICT into curriculum, pedagogy, and assessment to enhance learning and develop competencies for the twenty-first century; (2) to provide differentiated professional development (PD) that is more practice-based and models how ICT can be effectively used to help students learn better; (3) to improve the sharing of best practices and successful innovations; and (4) To enhance ICT provisions in schools to support the implementation of MP3.

6.2.2 Approaches to Scaling

In the process of sustaining and scaling educational innovations, different strategies can be adopted and applied. To help illustrate the Singapore approach to innovation sustaining and scaling, a scaling strategy framework is first presented.

Four sets of scaling models and strategies can be characterized with reference to its sustaining and scaling purpose/outcome (as centralized vs. decentralized) and its methodology/process (as top-down vs. bottom-up) (see Fig. 6.1). In the "centralized" model, the government has a strong presence in enacting directions/policies, taking initiatives, and playing driving forces. The agents in centralized

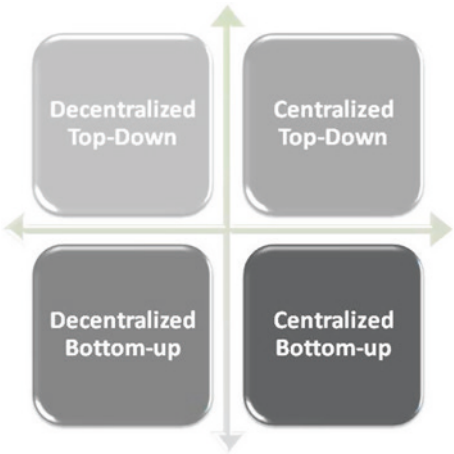

Fig. 6.1 Strategy models for sustaining and scaling up innovations

sustaining and scaling can either be assigned (top-down) or motivated (bottom-up) to spread certain innovations for certain outcomes, purposes or themes. In "decentralized" models, there is no predefined or definite central theme to make all the agents united together. Instead, competition and symbiosis for different scaling themes or factions are encouraged. Take decentralized bottom-up sustaining and scaling for instance, in this model the agency really springs from the ground (grassroots) and the government has a minimum influence. Sustaining and scaling is about the building up of constituency. It can be achieved by collaboration with industry partners, or driven by technological or business initiatives.

In Singapore, "centralized" is one of the characteristics of policy implementation. This is also the case in the making and implementation of the educational policies. The strategies and mechanisms incorporated in MP3 for sustaining and scaling innovations are mainly situated in the centralized top-down and centralized bottom-top quadrants. Centralized planning by MOE on intended outcomes, processes, and support strategies for implementation is prominent. In the centralized top-down model, spread is coordinated and driven from the top. Different levels of prescriptiveness and different types of disseminations using a variety of mechanisms such as programs (e.g., workshops), materials, and headquarter staff as resources, etc. can be engaged. Some examples of the top-down strategies applied by Singapore MOE include implementing base-line ICT standards for students, developing and providing school self-assessment tools for assessing technology usage and integration, and driving the Future School program in which seed schools are appointed as the pioneers for cultivating and spreading innovations (MOE 2009).

In the centralized bottom-up model, policies are set in place to encourage innovations, pinpoint directions, provide resources and funding, aggregate lessons learned from implementation to iterate the innovation, and support the innovations initiated and advanced by the ground-level agents has been integrated as well. Bottom-up strategies such as supporting schools to launch their own ICT initiatives with funding from the eduLab program (MOE 2009) are also making positive contributions to the sustaining and scaling of the change emerged in the educational landscape.

In essence, the approach employed in MP3 to enhance the sustainability and scalability of educational innovations is multipronged and multidimensional. The diversified strategies and mechanisms incorporated are working in tandem in systemic ways to bring about adoption and adaption of the innovation. As a national initiative, this is akin to the Digital Textbook initiative in South Korea (Kim and Jung 2010) which also incorporates top-down and bottom-up elements for fostering agency of change.

6.3 Case Studies: Sustaining and Scaling Design-Based Research Innovations

Guided and supported by the imperatives set and enacted by the government at the macro-level in the Singapore context, researchers as the meso-level agents have made continuous efforts to advance understanding about the processes of

designing and implementing innovations that can impact peer-researchers, practitioners and policymakers via the design-based research (DBR) approach. DBR highlights the rending of plausible solutions to complex problems in authentic contexts through iterative cycles of learning design-implement-redesign, and the co-evolution of theory and practice (Collins et al. 1992). The focus is on the adaptation of innovations rather than adoption with fidelity.

Research that can lead to interesting and significant findings, with the design of successful innovations in which the trajectory comprises the design and enactment of interventions, doing and studying the subsequent implementation of the interventions, and implementing in various situations that provide compelling evidence of what works and what does not in terms of sustainability to improve learning at a systemic level, and in addressing the learning needs of diverse populations of students to enable scaling, is conducted with rigor. Partnering closely with the practitioner community, and supported and supervised by MOE, the DBR innovations established in research institutions (e.g., Learning Sciences Lab (LSL) in the National Institute of Education—NIE) that have proved enhancing students' learning gains in traditional measures of learning, improving their values, attitudes, beliefs, and dispositions as well as enriching their twenty-first century learning experiences and competencies (e.g., collaborative problem solving and critical thinking skills) are being successfully sustained and scaled to bring about prolonged and extensive impact on school practices.

In the following, two case studies of the DBR innovations which have shown promise of sustainability and scalability (i.e., Groups Scribbles-Supported CoL, and Seamless Learning) are introduced. Through reviewing and reflecting on the development trajectories of these two projects, the conditions and factors that serve as the foundation for sustaining and scaling research-based innovations are summarized for informing the future practices.

6.3.1 A Journey of Adoption and Adaptation

6.3.1.1 Group Scribbles-Supported Collaborative Learning

An example of a research project that has shown potential for sustaining and scaling is the one that introduces a pedagogical innovation, i.e., rapid collaborative knowledge improvement (RCKI), to primary and secondary schools in Singapore (Looi et al. 2011b). The innovation is supported by the use of a technology for lightweight instant interaction, namely Group Scribbles (GS), co-developed by SRI International and LSL. It enables the concept of RCKI, namely the notion of democratizing participation and idea refinement in the context of live dynamic classroom settings, that is, face-to-face collaborative knowledge construction and improvement over the duration of a class session, and supported by certain technologies for lightweight instant interaction.

GS is designed for supporting generalized coordination among teacher and students, its workspace is divided into private and public spaces presented in a

two-paned window. The lower pane of the GS is the user's personal workspace or private board, whereas the upper pane is the public board or public board. The private workspace was provided with a virtual pad of fresh scribble sheets on which the user could draw or type. The students can share the scribbles sheets by dragging them from private space to public space. The essential feature of the GS is the combination of the private board where students can work individually and group boards or "public boards" where students can post the work and position relative to others', view others' work, and take items back to the private board for further elaboration.

Starting from one school, GS-supported RCKI has been adopted in the classroom lessons for different subjects to varying degrees of depth and breadth to more than ten schools (please refer to Looi et al. (2010, 2011b) for the details about the GS technology and examples of GS-supported RCKI activities).

The GS journey started in the year of 2007. The first school we worked with was Mayflower Primary School. Subsequently, the routine-based CoL was introduced into three other secondary schools. During the process, we worked in close collaboration with the school practitioners to establish and enhance both the pedagogical and technological architectures for supporting CoL. Altogether 109 GS lesson plans have been created in various subjects (Mathematics, Science, English/L1, and Chinese language/L2), and 146 GS lessons have been enacted, observed, and studied. To improve the design and enactment of collaborative pedagogies by the teachers, numerous PD sessions and more than 100 GS lesson discussions have been conducted with the teachers.

This rigorous and committed school-based research has produced good harvests. Through our intervention, the students had deeper learning of the subject matter, stronger motivation, interest and enthusiasm in the learning activity, and better CoL competencies and skills. The teachers had improved their understanding and competencies of the design and delivery of CoL and ICT-supported learning activities as well. Through iteration, CoL design principles, pedagogical patterns, and activity designs that found effective in transforming and improving the practices in traditional classrooms were drawn and documented. The interventionistic and iterative research practices in the long run also helped shifting the school culture as being individualistic-based to collaboration-oriented. All these provide strong bases for the sustaining and scaling of the innovation.

Building on the researchers' effort, the four schools have continued pursuing the innovation on their own. Informed and encouraged by the success in these research interventions, the Education Technology Division (ETD) of MOE proceeds to work with another six schools to bring in GS as "deep" interventions. Besides the action from the government side, the research team has also played an active role in disseminating the innovation. Leveraging on the two workshops held during Jan–Feb 2010, the GS impact has been announced to 50 teachers from more than 20 schools. Motivated by the needs and the potentials of GS to inspire transformation in existing school practices, other local schools have also adopted and adapted the innovations on their own. This spontaneous and voluntary participation by the practitioners provides fresh fuel for the further extension and spread of the innovation. In NIE

itself, GS pedagogy has been introduced to many cohorts of Leaders in Education Programme (LEP) and Leadership in Schools (MLS), and to students taking the core Academic Group Instructional Technology modules in the faculty of Learning Sciences and Technology (LST). Through these multiple channels of dispersal, a broad spectrum of personals at different levels have been informed and involved. Thus the expertise and resources from diverse sources can be engaged and harnessed to empower the sustaining and scaling of the GS innovation.

6.3.1.2 Seamless Learning

Another research-based innovation that has been successfully sustained and scaled is the "Seamless Learning Model (SLM)" which is framed in the broader context of constructing "seamless learning" environments to bridge different learning contexts (such as between formal and informal learning settings, between individual and social settings, and between physical and digital settings) mediated by mobile learning devices on a 1-to-1, 24/7 basis. This DBR research is motivated by the infeasibility to equip students with all the knowledge and skills needed for lifelong solely through formal learning (or any other single learning space). To address this issue, SLM, in which student learning moves beyond the acquisition of content knowledge to the development of capacity to learn seamlessly, has been designed, implemented, and further improved based on the reflections and feedbacks accumulated via iterative cycles of sustaining and scaling (please refer to Zhang et al. (2010), Looi and Wong (forthcoming), for the introduction of SLM and examples of learning activities using SLM).

SLM was developed in the 3-year research project entitled "Leveraging Mobile Technology for Sustainable Seamless Learning in Singapore School" which was also based in LSL. In this project, the research team worked in close collaboration with Nan Chiau Primary School (NCPS) to develop SLM. SLM encompasses innovations at different aspects, including epistemology (i.e., learning as drawing connections between ideas, and learning as connecting science to everyday lives), curriculum (i.e., seamless learning, and inquiry-based facilitation, and learning), and technology (i.e., technology for construction, communication, and for searching information anywhere anytime).

Like GS, the SLM innovation also went through a process of expansion. In the year of beginning (2009), only one teacher and one Primary three classes were involved. Then in the following year (2010), two teachers, and two Primary four classes went aboard. The school-based research had produced exciting results within the 2 years' time: the existing science curriculum had been transformed into an inquiry-based one that can well leverage on the affordances of mobile technologies; the students had better learning of the subject in the seamless learning environment established, and they had moved from the instructivist form of learning to the inquiry-oriented one; there were positive changes in the teachers' knowledge, competencies and attitude toward inquiry-based pedagogy; the mindset of the school leaders and administrators was gradually shifted toward the innovation; the pedagogical and technological schemes developed improved the school's capacity

to support and sustain the innovation on their own. These stage successes all contributed to the further diffusion of SLM to make a more significant impact.

NCPS scaled the mobilized curriculum for science to all Primary three classes in 2012, and then to all Primary four classes in 2013. Meanwhile, SLM has been translated into other classes on different subjects. Starting from 2012, the SLM for English language (L1) learning has been designed and implemented in three Primary three classes. Currently, more classes and more grades are using SLM for their English learning. Now the same research team has embarked on the design and delivery of SLM for Chinese language (L2) learning with the school under the MoveIdioms and MyCloud scale-up initiative. Except for spreading the innovation across classes, teachers, grade levels and subjects, the team also plans to invite teachers from five other schools in the same school cluster to learn more about this innovation so that these teachers can in turn seed their own innovations in their schools.

It is expected that when the innovation has been taken to the zone or cluster level, further dissemination will grow from there. Besides these ground-level efforts, expertise and resources from the government bodies such as the Curriculum Planning and Development Division (CPDD) and ETD under MOE are to be involved to support the adaptation and adoption of the innovation to further the spread.

6.3.2 The Affordances of DBR for Sustaining and Scaling Innovations

Based on these systemic and multilevel efforts and mediated by the meso-level research community, both the DBR innovations have gained their recognition, even in the international area (e.g., GS has been cited in the USA's National Educational Technology Plan (2010) as a successful innovation tried out in Singapore schools).

These two case studies deepen the understanding about how to help the school practitioners (e.g., the school leaders, administrators, and teachers) transform the school practices with researchers playing a meso-level role that helps interpret policy directives at the macro-level and assists the school side to build up the mindset and the capacity and to design and deliver practices that meet these directives (e.g., to design and enact collaborative lessons in which productive classroom discourses are enhanced based on the digital artifacts in the GS project). Researchers have taken the challenge of conceptualizing and articulating the innovations that embody and encompass the outcomes, processes, and strategies prescribed by the policies basing on their knowledge and expertise. The research community proceeds to motivate and engage school agencies at the microlevel to implement and improve these innovations to enable sustaining and scaling.

In the processes of envisioning the innovations and translating the designed innovations into the specific school contexts, appropriate mechanisms should be incorporated. For the two innovations described in this section, the key to success was the adoption of the DBR approach which emphasizes on close collaboration

with the school practitioners in designing and implementing the innovation. Deeply involved in the school practices as required by DBR, the researchers could develop good understanding about the background, the current status, and the potentials that might facilitate or barricade the adoption and adaptation of the innovation. Referring to the Strength, Weakness, Opportunity and Threat (SWOT) identified in the partner schools, solutions that specifically catered to the school's features and culture could be conceived. This to some extent ensured the smooth implementation of the innovations. For instance, through active interaction with the school side, the researchers could identify the tensions existed in the school that might cause disturbance of the adaptation and adoption of the innovation and thus concoct remedy accordingly. A worked example for this is the development and delivery of extensive PD and lesson discussion sessions for teachers which helped equip the teachers with both the awareness and abilities to design and enact the innovative learning practices in both projects. These efforts well mediated the tension between the teachers' individual capacity and desire to change and the imperative of school leaders for teachers to innovate that had been found hampering the implementation of the innovation. Also, with the cognition of the conflict between the prospective to develop students' twenty-first century competencies and the priority of learning the subject matter as indicated in the curriculum and syllabus, the lessons and learning activities designed in the GS project all tapped the existing curriculum in the schools, which avoided interruptions in the established class schedule and scheme of work that might caused resistance from the teachers.

The second critical affordance of DBR for sustaining and scaling innovations lay in the co-designing of lessons and learning activities by the researchers and teachers. This practice benefited as it could improve the ownership and autonomy by the teachers. Also, in the processes of co-creating and reflecting upon the learning experiences designed and provided to students, a common language (which might include the terms and concepts for understanding and using the technology, the principles and models for lesson and activity design, and the frameworks and procedures for evaluating and assessing students' performance, attitudes and learning gains) should be provided to enable the communication between the researchers and teachers. These artifacts created throughout the processes of DBR could be used to mediate the further spread of the innovation and the continuation of the innovation. In both the GS and the seamless learning projects, such design principles (e.g., GS RCKI principles: Looi et al. (2011a), SLM design principles) were drawn and accumulated with an eye for sustaining and scaling. Moreover, considering the gap between research and practice, the common language established should be manageable to the school practitioners. Take the PCKI principles as an illustration for this. Leveraging on the knowledge established in Computer-Supported Collaborative Learning (CSCL) research (i.e., the Knowledge Building principles) (Scardamalia and Bereiter 2006), 10 RCKI principles were initially incorporated to guide the co-designing of GS lessons and learning activities. Yet taking into account the difficulty of the teachers in understanding the concepts and the application of these abstract principles, the RCKI principles were condensed into six simpler guidelines for teacher use (Looi et al. 2011b). Observations made indicated that the teachers were ingrained with these guidelines for designing pedagogy, so even without

the use of the GS technology the teachers would incorporate the notions of rapid collaborative idea improvement in their own teaching.

The third distinguished feature of DBR which stresses the importance of phasing change and iteration could make more room for adoption and adaptation of the innovation and thus enhance its sustainability and scalability. Following the DBR approach, the innovative form of teaching and learning as developed in the GS and seamless learning projects did not replace the traditional all at once. Instead, the innovation was positioned as a process of progression, with certain goals and outcomes expected at each phase. This approach allowed more buffering time for cultivating the mindset and building the capacity for systemic change. Accomplishing the objectives prescribed for each stage eventually led to the fundamental change as expected when the readiness had been created. A good example of the acts of phasing change was that in both two projects, substantial enculturation was provided to the teachers and students during which they gradually appropriated the practices of using the technology and of participating in the learning and teaching activities designed. As the participants were "remoulded" in a subtle way, the effect of the inertia was minimized. This offered good opportunities for the ongoing adoption of the innovation. On the other hand, the iterative nature of DBR made it a particularly suitable approach for realizing the innovations as the possibility of recursive design and implementation allowed empowered the adaptation of the innovation to be translated across contexts and audiences. The iterative cycles of designing, implementing and evaluating, and improving the solutions to the problems identified that integrated known principles and hypothesis could also enable the creation of new knowledge (e.g., theories of learning, design principles) that could inform the future practices as aforementioned.

6.4 Reflections: Conditions for Sustainability and Scalability

In this section, the factors which have led to the sustainability and scalability of these two innovations are analyzed. Some of the factors are the outcomes of strategies and choices adopted in the implementation of the research, and some are extraneous to the innovation per se. These all provide some of the conditions for innovations to take root in practice.

6.4.1 Government Presence for Objective Alignment and Effort Orchestration

The quality of education is one of the most critical indicators for the competitiveness of a nation (Schwab 2012), and has great predictive power for the future of the nation. Singapore, though being a small city–state with limited material resources and manpower, has long been striving for the transformation of the

education established in the industrial era into the one that is demanded in the knowledge age.

The Singapore success in the sustaining and scaling of educational innovations enabled by ICTs can be attributed to the strong government presence in monitoring, adjusting, and evaluating the outcomes, processes, and support strategies for ICT-enabled transformation and improvement in learning. In planning and delivering MP3, MOE not only clarifies the goals intended, but also elaborates on the roles and responsibilities for each party involved and the mechanisms to be incorporated, all toward the central theme of "strengthening and scaling" ICT-based innovations. For instance, to ensure that teachers have the capacity to plan and deliver ICT-enriched learning experiences for students to become self-directed and collaborative learners, MOE provides incentives and structures for teachers in Singapore to champion, share and contribute to the use of ICT in SDL and CoL. Concurrently, MOE develops and embeds core ICT-enriched learning experiences in appropriate syllabuses, articulates, and guides the implementation of learning roadmaps for differentiated support, provides quality online resources and support for the sharing of resources, leads experimentation in the use of ICT for assessment, and establishes mechanisms to translate research into usable principles (MOE 2009). These commitments are embodied into a series of projects such as ICT Mentors, ICT-PD Framework, FutureSchools, and Edulab which engage contributions from macro-, meso-, and micro level agents (MOE 2009). These provide a positive socio-political and socio-cultural context for motivating and building up the capacity of teachers to understand and undertake innovations. With these guidelines, though multiple stakeholders are involved, their efforts and actions can be orchestrated to achieve the common objective. In other words, it is the strong government initiation, coordination, and supervision that help ensure the coherence of the educational ecology in Singapore where the transformation and improvement in learning emerges and evolves. We do realize that these contextual conditions of a strong top-down government role may not be shared in other countries and regions.

6.4.2 DBR Commitment for Systemic Change

Though the sustaining and scaling of educational innovations in Singapore is geared toward a centralized outcome, yet the processes and methods engaged can be either directed by the macro-level agents or initiated by the ones at the meso/micro levels. In sustaining and scaling, the key challenge lies in the general resistance to change and the preference for the status quo as change involves taking risks. The efficiency model of stable routines needs to give way to innovation mindsets willing to take calculated risks in encouraging bottom-up experimentations and innovations. This calls for dynamics from the bottom (the research institutions, industrial partners, and schools). The schools are the implementers and they can provide feedback from the ground to the policymakers. Data and evidence collected by researchers can serve an important mechanism in complementing the possible setbacks in centralized scaling.

The government has acknowledged the value of researchers/practitioners-initiated efforts for sustaining and scaling the change for long and has been committed to providing incentives and supports.

In the Singapore context, there exists close collaboration between the educational researchers and the schools to produce innovations though the DBR approach that can impact the existing school practices (which are distinguished from the experimental studies conducted in laboratory settings whose emphasis is on the establishment of the efficacy of the design). As discussed in the section above, the affordances of the DBR approach can facilitate the sustaining and spreading of the innovations cultivated. Moreover, as the DBR aims to address the complex problems in authentic learning contexts which incorporates multiple inter-related factors such as the configuration of the curriculum, pedagogy and assessment, the technological infrastructure, and the teachers and students as the main actors, the researchers, once has embarked on this endeavor, need to seek solutions on all these dimensions. Apart from the technology innovation, more efforts are required to develop and deliver alternative curricula, pedagogies, and assessments, and enculturation and teacher PDs to foster effective and productive teaching and learning. The products and strategies achieved can be integrated to empower systemic change which also provides conditions for sustaining and scaling. Industrial partners can also come onboard to market and service the innovation as it goes into the market, increasing its sustainability and scalability.

6.4.3 Stage-Based Progressions for Long-Term Transformation and Improvement

In Singapore, the transformation and improvement of the educational system is planned upon learning from the best practices in the world, regular consultative processes, and effective implementations by personnel across the system. Each stage, with its unique focus and highlights, is built on the achievements made and gaps identified in the previous stage and instrumental to the conceptualization and implementation of the goals, processes, and strategies for the next stage. MP3, which stresses on the sustaining and scaling of ICT-based innovations to empower twenty-first century teachers and learners, is indeed the extension and progression of the attainments in the first two masterplans. The long journey that has been traveled so far in essence is the accumulation of the small steps and little progress made in the past, and the fruition of the long-term commitment and devotion to "harnessing ICT for future learning." The developmental trajectory of the national initiative to transform and improve learning with the leverage of ICT at the macro-level can be applied to any attempt to transform and improve learning at different scales. It is applicable to the realization of MP3, and even the design and implementation of the DBR-based innovations such as GS and SLM.

For any endeavor made at any level, the stakeholders need to have realistic expectations on the pace for change. Systemic plans should be made and implemented to

address issues and challenges existing and emerging during the implementation journey. For instance, when an innovation in learning has been introduced to schools, it is likely that there will be issues and challenges to the uptake of the innovation. There may not be alignment of the alignment of learning outcomes to standardized testing and high-stake examinations, trade-offs of teaching for deep learning in contrast to covering the curriculum, inadequate recognition and appreciation of the value of the innovation, and the lack of alternative assessments of students' learning gains, especially in terms of SDL and Col that pertain to the innovation. All these issues need addressing if the innovation is going to impact and to scale and sustain. Therefore the stakeholders involved should aim at steady progression to empower real transformation and improvement in learning.

6.5 Conclusion

We hope sharing the conceptualization and implementation of MP3 and the sustaining and scaling journey of two research-based innovations provide a microcosm of the issues and challenges of mainstreaming and scaling research-based innovations in a school system or district. The education system of Singapore has its unique characteristics such as being a centralized system with curriculum and national assessment overseen and developed at the Ministry's level. While the policies, the goals, the strategies, and the implementation of MP3 are probably unique to Singapore, we believe that there are lessons which can be distilled at a macro-level or at a microlevel that are informative to others involved in the mainstreaming and scaling of technology-enhanced learning innovations in the international community. This chapter can be a stimulus to generate further discussions that can help reflect on the experiences of these two research-based innovations and whether these innovations can thrive in different contextual conditions where different policies, goals, strategies, and implementation programs are in place.

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Chapter 7
ICTs as Transformative Enabling Tools in Education for Sustainable Development

Vassilios G. Makrakis

Abstract ICTs show an accelerated development both in terms of innovation and proliferation across all social, professional and educational domains. This generates a demand for new educational approaches and pedagogies that can foster transformative learning and the reorientation of educational curricula to address sustainable development. This Chapter discusses ICTs potential as transformative tools in teaching and learning with the focus placed on sustainability education. It is shown that ICTs offer opportunities for educators, but there is need for professional development as perspective transformation, a process whereby prospective teachers critically examine their beliefs, assumptions, values and personal theories as they are learning technologies and acquire new knowledge and experience.

Keywords ICT · Transformative learning · Education for sustainable development

7.1 Basic Education: Trends in Light of the Global Sustainability Crisis

We are increasingly confronted with complex social, economic and environmental problems locally and globally. Humanity is living a crisis of sustainability that includes not only environmental issues such as climate change, ozone depletion, biodiversity loss, but also economic and social issues, such as poverty, social inequalities, violation of human rights, gender inequalities, loss of indigenous knowledge, etc. As depicted in Fig. 7.1 (UNDP 2013), that sums up at a glance these

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R. Huang et al. (eds.), *ICT in Education in Global Context*,
Lecture Notes in Educational Technology, DOI: 10.1007/978-3-662-43927-2_7

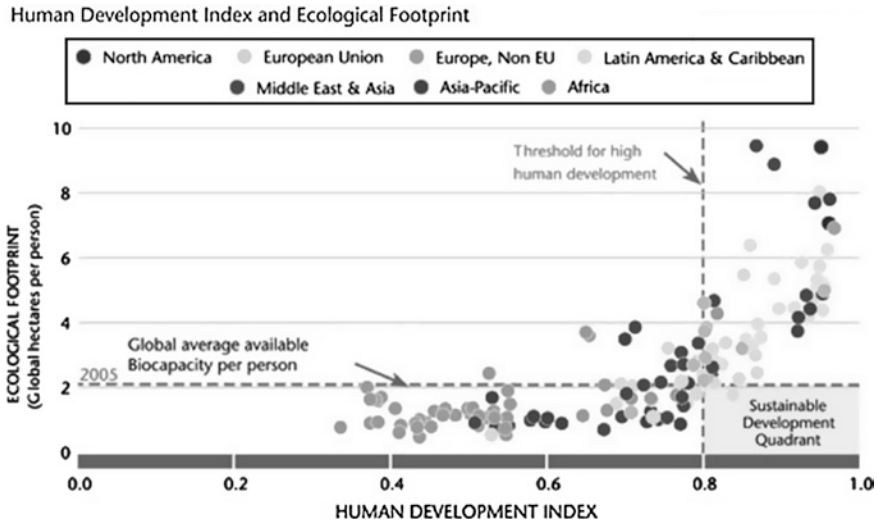

Fig. 7.1 Human development index and ecological footprint worldwide

sustainability challenges, countries to the left of the vertical line are marking a score of 0.8 on the Human Development Index, which implies that people are not sufficiently meeting their basic needs, while expenditure in weapons takes much of government budgets. In countries above the horizontal dotted line and to the right of the vertical line, people, mostly from the economically rich countries are meeting their needs, but in ways that destroy ecosystems.

It is true that the prevailing economic and monetary model has increased the people's purchasing power in the most affluent societies but in turn it generated unsustainable modes of production and consumption. Even though global consumption has reached its higher peak in recent years, access to basic needs such as education, health and food has not been met. It is estimated that of the more than six billion people on Earth, over 1.1 billion people in the developing world cannot afford the necessary for their human survival, 2.5 billion people lack access to improved sanitation, 101 million children are not attending primary school, with more girls than boys missing out and 4 million newborns worldwide are dying in the first month of life (UNICEF 2010). The report of the Center for the Global Development (2002) states, that educated mothers are 50 % more likely to immunize their children than mothers with no schooling. It is also assumed that greater female education leads to more productive farming and accounts for over 40 % of the decline in malnutrition achieved since 1970 (UNICEF 2010). Thus, education gives people the skills they need to tackle sustainability problems, such as poverty, violation of human rights, unfair trade and promote democracy, civic engagement and participation. Summing up, the sustainability crisis is largely based on the:

1. Unsustainable modes of production and consumption
2. Increased proliferation of military expenses and unsustainable use of technology

3. Generation of growing gaps of social, economic and political inequality
4. Globalization of the market economy driven by greediness of capital accumulation.
5. Lack of sustainable basic education.

The World Conference on Education for All (1990) used the term 'basic education' to refer to all forms of organized education and training that meet the basic learning needs of individuals, including literacy and numeracy, as well as the general knowledge, skills, values and attitudes required to survive, develop their capacities, live and work in dignity, improve the quality of their lives and make informed decisions. The Education for All (EFA) movement is a global commitment to provide quality basic education for all children, youth and adults. EFA entails a vision and a set of objectives adopted by the world's governments and international organizations in Jomptien, Thailand in 1990 and a decade later in Dakar, Senegal. The Dakar Framework for Action (2000) addresses among other things the learning needs of all young people and adults through equitable access to life skill programmes, especially for women. After Dakar two EFA goals were incorporated in the Millennium Development Goals (MDGs) for achieving universal primary education, promoting gender equality and empowering women Dakar Framework for Action (2000). Indeed, EFA goals are critical to attaining all the MDGs and other sustainability goals. However, the tangible but modest gains achieved in relation to EFA in the past decade still call for caution since there remains considerable social selection in education and disparities in particular that have persisted, especially in the low socio-economic groups (Kadzamira and Rose 2003). As it is pointed earlier, basic education as well as other levels of education bears their own responsibility for the current environmental, social and economic crisis. This has raised the issue of transforming basic education to respond to the current sustainability challenges.

7.2 Transforming Basic Education Toward Sustainability

Basic education can be a driver rather than a barrier to building a more sustainable society. The concept of sustainability or sustainable development is very complex and may mean different things to different groups of people. The classical Brundland (WCED 1987, p. 43) definition for sustainable development "allows current generations to satisfy basic needs without depriving future generations of the same right". In a panel review of 37 experts, sustainable development was consensually defined as "to making informed, contextual and conscious decisions driven by the principles of solidarity, justice, accountability, equity and transparency for the good of present and future generations, locally and globally and to act upon those decisions for advancing social, economic and environmental wellbeing" (Makrakis 2011b, p. 411). Basic education as any type of education has been seen as one of the most critical factors to promote sustainability. An education for sustainability is geared towards: (1) developing the values, behaviour and lifestyles required for building a sustainable future; (2) encouraging learners' civic engagement; (3) promoting learning to transform oneself and society and (4) developing the knowledge

and skills needed for a sustainable future as well as changes in values, behaviour and lifestyles. In a report released on September 2013 by the U.N. International Panel on Climate Change, scientists say they are 95 % confident that people are to blame for at least "half of the observed increase in global average surface temperatures since the 1950s. The confidence level back in 2007 was 90 %percent. In 2001, scientists were only 66 % confident that people were partially to blame. The report also concludes that even if the emissions of greenhouse gases were stopped entirely, it would take centuries to undo the damage (The Economic Times 2013). It has to be recognized that many of the sustainability problems are related to our ways of living, and that solutions imply major transformations at the personal and social level. This draws attention to the economic and political structures which cause unsustainable modes of production and consumption and other forms of social and economic injustices. It also draws attention to the need for a shift of consciousness that alters: our way of being in the world (learning to be), our way for discovering others by discovering ourselves (learning to live together), our way of learning how to learn as well as appreciating all sorts of knowing (learning to know) and our way of putting knowledge into action (learning to do) (UNESCO 1996). It is above all learning to "transform problematic frames of references—sets of fixed assumptions and expectations—to make them more inclusive, open reflective and emotionally able to change" (Mezirow 2003, pp. 57–58). Freire's (1970) concept of critical consciousness in the context of emancipatory sustainability learning implies going deeper into the root causes of sustainability problems rather than focusing on their symptoms. In that sense, people, especially the voiceless and excluded need to develop the required critical consciousness (conscientisation) in order to challenge the ideas and structures that limit their potential to change themselves and society. Through the process of critical consciousness, learners regardless of age can learn to identify, interpret, criticise and finally transform their unsustainable values and practices and collectively work towards changing the unsustainable world. Crucial to this process is the notion of praxis—by which Freire means 'reflection and action upon the world in order to change it'. More simply, it means being able to make the connection between experience, knowledge construction, and transformation to bring about personal and social change (Makrakis and Kostoulas-Makrakis 2012). This process is supported by the following learning processes conducive to education for sustainability (Tilbury 2011; Kostoulas-Makrakis 2013).

1. Learning to ask critical questions;
2. learning to clarify one's own values;
3. learning to envision more positive and sustainable futures;
4. learning to think systemically;
5. learning to respond through applied learning; and,
6. learning to explore the dialectic between tradition and innovation.

In particular, learners need to learn how to clarify and reflect critically on their values and practices exercised in their place of living and to consider what sustainability means to their way of living. They need to practice envisioning alternative ways of being and living, learning how to negotiate and justify choices

and get active involvement for building a more sustainable world. How can these learning processes underlying active citizenship be enabled by Information and Communication Technologies (ICTs) and turn education to function as an agent or driver and not a barrier for change?

7.3 ICTs as Transformative Enabling Tools for Sustainability

One emerging area concerns merging ICTs with education for sustainability (Makrakis 2012a; Makrakis and Kostoulas-Makrakis 2012). The link between ICTs in education and education for sustainable development (ESD) is being addressed by extensive debates and research which recognize the challenge new technologies bring to the transformation of education towards learning to live sustainably (Makrakis 2006, 2008, 2011a; Paas 2008). From an instructional and learning perspective:

- ESD themes integrated into the school curricula could provide a worthwhile context for ICTs in education. For example, social, economic and environmental issues can provide meaningful and challenging contexts for developing a wide range of ICT skills.
- ESD methods can provide a context and rationale for using ICT-based learning tools such as concept mapping, modelling, social networking etc.
- ICTs can provide opportunities for learners to construct meaningful sustainability learning environments enabled through processes such as: (1) engaging and challenging learners with local sustainability themes; (2) stimulating dialogue and social negotiation through new modes of social interaction; (3) learning by exploring, experiencing, discovering, constructing, reflecting and acting and (4) enabling learning through open and flexible modes of teaching in order to reach the disadvantaged groups.
- ICTs can help learners explore concepts, engage in problem-based and authentic learning, enhance meta-cognitive skills and present information using multiple media (Makrakis 2011b) such as, ecological footprints, visual graphic organizers, electronic portfolios, notebooks etc. All these tools can help learners explore and address problems in a real-life situation as well as being used as critical reflective scaffolds on the problem-solving process. Studies show that ICTs give voice to the voiceless and it has been documented that video has given voice to non-literate indigenous communities by bridging "the oral with the technical", thus allowing their voices to be heard in global forums (Guidi 2003, p. 253). The promise of digital technology is in its capacity to turn excluded consumers of communication into active producers (Shaw 2012). ICTs have also facilitated intergenerational knowledge transfer (Chikonzo 2006) and have promoted empowerment, social participation and advocacy (Makrakis 2012b; Mathur and Ambani 2005). Participatory video projects, for example, have allowed marginalised groups "to assert their own political agency and cultural values" (Turner 2002, p. 230).

Through an ICT-enabled Problem-Based-Learning (PBL) process, both learners and teachers have an opportunity to develop skills in problem definition and problem solving, to reflect on their own learning, knowledge and practices, and develop a deep understanding of the content domain learning. In such an approach, the problem is often stated in the form of key questions, such as the following:

- How can I use computerized graphic organizers to teach vocabulary relevant to environmental sustainability issues?
- How can I use data handling tools (e.g. Excel) to enable construction of knowledge and promote learning-based action on ESD local/global issues?
- How can I use ICT to develop and critically reflect on my ecological footprint?

The interactive nature of hypermedia technology provides unique capabilities for the implementation of problem-based environments that can enhance education for sustainability. However, media, interaction tasks, navigation etc. should follow sound interface design principles if we expect to play a critical role as enabling transformative tools for sustainability. Experiences in carrying out teaching interventions dealing with ESD themes and PBL methods supported by ICTs indicate that such an interface should take into consideration: (1) using problem-based learning scenarios linked to local sustainability issues in audiovisual/hypermedia format; (2) employing critical thinking scaffold as knowledge elicitation systems that could also assist teachers as action researchers; (3) exploring the advantage of technology to provide opportunity for support and reflection on both the content learned and the learning process; and (4) connecting ICTs with learning techniques that foster higher-order thinking skills, support decision making and involve participatory learning. This implies the need for teacher education curriculum revision which will aim at:

- Empowering future teachers to develop their instructional skills actively and experientially, in a variety of learning environments, both individually and collaboratively.
- Providing an authentic learning environment so that future teachers engage in concrete tasks within realistic and problem-solving learning scenarios.
- Emphasizing ways that technology can facilitate and enhance future teachers' professional roles in building a more sustainable future.

It is clear, that although, ICTs can play a key role in ESD/EfS by providing both learners and teachers with new tools that can transform and enrich instructional roles, curricula, and practices, technology by itself is not likely to contribute, unless it is based on sound pedagogical principles (Makrakis 2010). Indeed, technology is not neutral; the penetration of ICT in education can eventually enable learning to transform oneself and society through applying a new pedagogy infused with methods such as critical self-reflective praxis. Such an approach applied to ICTs makes an explicit commitment to their potential for empowerment, advocacy and emancipation. Thus, the concept of praxis is not simply using ICTs to freeing people from lower cognitive demanded works, but to free learners from the forces that limit their options to ask critical questions, clarify own

values; envision more positive and sustainable futures and think systemically. It thus becomes clear that ICTs acting as enabling transformative tools for sustainability cannot be divorced from a critical pedagogy discourse and practice.

7.4 Merging Theory with Praxis: Some Examples

The UNESCO Chair ICT in Education for Sustainable Development at the University of Crete in cooperation with RCE Crete (Regional Centre of Expertise for Education for Sustainable Development) has taken initiatives for establishing a research unit undertaking a number of research projects in the field of ICT-enabled education for sustainable development, some of which are presented here.

7.4.1 Act for Climate-Enabled by ICTs

This project consists of two sub-projects: the first focusing on the integration of climate change education across the basic school curriculum (Makrakis et al. 2012a) and the second of the effects of climate change on children's human rights (Makrakis et al. 2012b). Both sub-projects consist of six thematic areas supported by various ICT tools (Figs. 7.1, 7.2). Learners are expected to gain insight into how climate change is altering the planet, potential impacts on the future, and how they can intervene to address its effects. The web-based environment includes interactive activities and supportive material on climate change.

The methodological approach used merges ICT, ESD, critical pedagogy and Climate Change Education (CCE) principles and practices. In developing the web-based learning for both applications, Drupal was chosen as the back-end system of the hypermedia learning environment. Drupal is a free open source Content

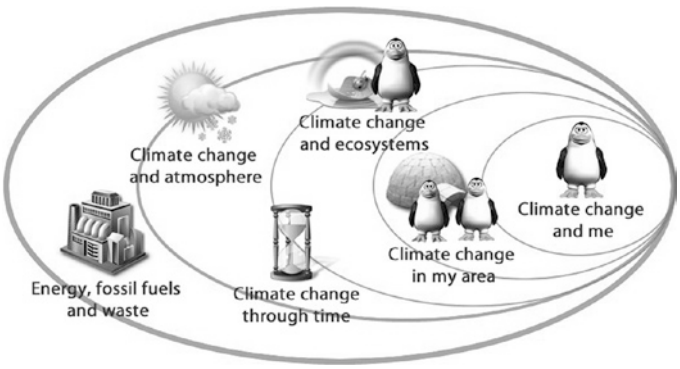

Fig. 7.2 The themes of the Act for Climate Change across the curriculum

Management System (CMS) written in PHP (Hypertext Pre-Processor) and distributed under the GNU General Public License. It includes a wide variety of useful tools such forums, wikis, blogs, quizzes, polls, sweepstakes and many other robust social networking modules. The main learning content of the Act for Climate Web-based learning environment is composed of learning objects (LOs). Each LO is constructed from various media assets, such as text, video, animation, charts and sound narration using Adobe Flash. The combination of Drupal and Flash provides a dynamic and adaptable learning environment. Moreover, the learning environment is enriched through the integration of various ICT tools, such as concept maps, spreadsheets, presentations, paint tools, word processing and a modern Greek online dictionary. Any supplementary material needed include relative web pages, web articles, case studies, videos, animations, general ideas or advice and help for teachers and students.

In the area "Climate change and me" learners are involved in the learning processes of clarifying their own values and asking critical questions about what climate change has to do with them (their school, family, nutrition, health, etc.) and what they can do in their everyday life (in school, home, neighbourhood, local area) to face climate change using various ICT tools. Then, learners can move to the area "Climate change in my area" and investigate how climate change can affect their local society and economy. The next area, "Climate change and ecosystems", gives learners the opportunity to think systemically and explore their local and national ecosystem and the repercussions climate change brings upon it and other social systems. In the next area, "Climate change and atmosphere", learners deal with climate change as a natural phenomenon. The following area, "Climate change through time", gives learners the opportunity to get involved in the process of envisioning and assessing alternative futures about climate change based on the past and present situation. Finally, in the area "Energy, fossil fuels and waste", learners investigate what climate change has to do with energy, fossil fuels and waste, focusing on how to save energy and reduce waste. They search for ways to sustainability meaning making, knowledge construction and transformation, using renewable sources of energy and new ways to handle waste. Learners can choose any of these units to start with and engage to its activities enabled through various ICT tools. Thus, the units and activities may be implemented either sequentially and/or according to the existing curriculum organisation of content and needs. Alongside the activities conducted in the classroom, many activities outside the classroom are suggested, referring gradually from the local to national and global level.

In the web-based hypermedia application dealing with "Climate Change Education and Children's Rights" all the six themes or units consist of a whole that takes a human rights approach to climate change education. Through the unit entitled "Right to food and climate change", learners experience and conceptualise their nutritional needs while they are engaged in activities that lead to understanding food as a basic need and human right, using various processes such as critical reflection. The "Right to water and climate change" unit aims to make learners understand that access to drinkable water is a need which they have the right to

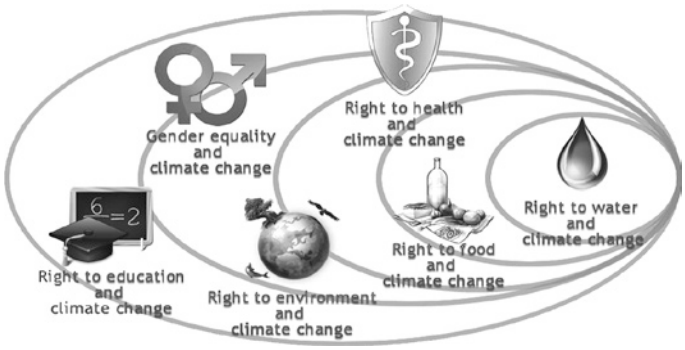

Fig. 7.3 The themes of the Act for Climate Change and children's rights

fulfil as well as to encourage them to get involved in actions for the protection of this right. Additionally, learners, through case studies activities, are experiencing how the denial of the right to water is related to some extreme local climate conditions which are due to the climate change phenomenon. The thematic area of education as a human need and right is explored in the "Right to education and climate change" unit. Learners are experiencing how the denial of the right to education is related to some local climate conditions, which are due to the climate change phenomenon. Climate change poses significant risks to the right to health for millions of people worldwide through the spread of a wide range of diseases. In the unit entitled "Right to health and climate change", learners experience and conceptualise their health needs while they are engaged in activities that lead to understanding health as a basic need and human right. Climate and gender issues are inter-related for several reasons. Women and men affect the climate in different ways. The unit entitled "Gender equality and climate change" aims to make learners able to understand the impact of climate change on children's life, education and health. It also attempts to make learners understand that they have the right to be treated equally, irrespective of their gender, as well as make connections between gender equality and the children's rights which are reviewed in other units of the learning environment. Both of these curricula applications enabled by critical pedagogy and ICTs are intended to be flexible, allowing the teacher to select some or all of the activities in order to help learners to develop learning activities and actively participate in the learning process (Fig. 7.3).

7.4.2 Empowering People Through Participatory Video

This is an action research project focusing on empowering people through participatory video integrated into an undergraduate course entitled "Curriculum and Hypermedia" in the department of primary teacher education at the University of Crete (Makrakis 2012b). The overarching goals of this course are: (a) to provide

a critical approach to curriculum supported by new advanced technologies in the context of education for sustainability; (b) raise awareness of the role of some technologies in enabling learners to reflect critically on the rights, roles and responsibilities of an active citizen in preparing for a sustainable future for all; and (c) use participatory video and social networking technologies as tools to empower themselves and the community, including children, for raising their voice. Upon successful completion of this course, students will be able to:

- Discuss the various epistemologies of curricula addressing issues of education for sustainability.
- Connect curriculum theories with hypermedia-based learning and education for sustainability.
- Develop a video-clip using suitable software (e.g. Movie Maker 2) contextualised with local/global sustainability issues.
- Use social media to raise awareness for action and advocacy from the bottom up.
- Develop a lesson plan that integrates the produced digital artifact addressing social, environmental, cultural and economic issues of local and global concern.
- Apply principles of transformative learning design together with visual and information literacy in creating hypermedia-based educational applications.
- Demonstrate awareness and ability to discourse on ethical issues in getting involved to PV production and in using social media and social networking tools.

To reach all the above, the course is structured into six sections. The first section addresses the perception of curriculum as product, process, and praxis. The second section discusses the three curriculum types in the context of hypermedia as transmissive, transactual and transformative learning technologies. The third section focuses on equipping pre-service teachers with the knowledge and skills to use participatory video and web-based social networking media as empowerment and transformative tools. Here, the course provides case studies, particularly related to local sustainable development issues, showing how children and other marginalised community members can be "empowered" to make their voices heard in the process for building a more sustainable society. The fourth section concentrates on developing participatory video-clips dealing with community-based sustainability projects. Using participatory techniques, such as focus group discussions, individual interviews and writing scenarios students are involved in gathering evidence from the children and other community members involved in making the participatory videos. The fifth section deals with: (1) the uploading of the participatory video clips produced into social networking media (e.g. YouTube, Face book) and (2) the integration of PV-clips into lesson planning. Finally, the sixth section engages participants in a self-reflective and reflexive process assessing the strengths and limitations of participatory video as a catalyst for learning to transform oneself and society. Through this course pre-service teachers and community members produce video projects that can be categorized as "authentic" learning activities because they take place in the "real world". Themes integrated into the video-clips developed so far concerned with environmental, social

and economic aspects of education for sustainability. Projects developed by students in cooperation with other stakeholders from the community included, for example, the issue of economic crisis through the eyes of school children, saving energy through alternative modes of mobility, children's violence and abuse, fair trade and the promotion of local economy and culture, sustainable tourism, etc. Through these applications enabled by ICTs and used for awareness-raising, advocacy and empowerment of those affected, students also developed competences on ICT skills. In addition, on the one hand, the processes adopted and implemented were driven by critical reflection that helped participants to deconstruct their prior assumptions such as beliefs and perceptions on the issues studied. On the other hand, it helped them to reconstruct their assumptions through meaning making.

Research results showed that participants in such a course felt ownership and control of their assigned projects, which was highly influenced by the visibility of their products through uploading them in the Web (Makrakis 2012b). They also developed technical skills such as: setting up and use lighting for shooting a digital video; recording audio tracks with video; using digital video cameras for shooting footage; creating characters using suitable software tools, graphics/logos; editing sound tracks for incorporation into a digital video; writing storyboards, etc. All these skills can be transferred to other situations and learning contexts. This PV intervention is seen by participants as a process that leads to transformative praxis as it involves participants in the process of defining what to do and how to do, acquiring ownership in what they do, and getting involved in a learning process that can empower them to transform their personal and social realities. In addition to that, this type of interventions helps to critically question the reproduction of the dominant ideology and existing power relations, as it strengthens advocacy skills, and promotes alternatives to norms and practices that reproduce inequities, violence and unsustainable behaviours. There is also evidence to support Giroux's (1988) concept 'teachers becoming transformative intellectuals', as participants in this course have started to critically question the dominant ideology of viewing their profession as technicians and transmitters of prescribed knowledge, carrying out dictates and objectives decided without their involvement.

7.4.3 WikiQuESD

This project also concerns another action research initiative integrated into ICT-oriented courses at the department of primary education at the University of Crete that focus on using ICT tools and digital media to turn pre-service and in-service teachers able to construct Web-based instructional material addressing education for sustainability issues. The concept of WikiQuESD has been developed as a collaborative scaffolding hypermedia tool to enhance teachers' education for sustainable development (ESD) and combines a Wiki platform and its technologies, the idea of WebQuest and an ESD approach (Makrakis 2010, 2011a). WikiQuESD is based on theoretical insights from critical or emancipatory constructivist research

and transformative/reflective learning with particular reference to education for sustainability (Makrakis 2010). The principal idea behind WikiQuESD is that teaching and learning should focus on the study of real-life problems and the learning process should be learner-centred. To support these features, WikiQuESD includes strategies such as: activation though various means such as conceptual mapping, Webloging, brainstorming etc. It continues through problem identification, identification of learning needs and tasks, processing and refinement of needs and tasks, construction and re-construction of new knowledge and continuous reflective feedback. These descriptors clearly call for pedagogical processes that are participatory, reflective and emancipatory. It also assumes that an attempt to re-orienting teacher education to address sustainability needs to be based on three inter-related pedagogical concepts: (1) contextual learning; (2) authentic learning and (3) transformative learning (Makrakis 2006). All of these are critical to enable transforming unsustainable values and actions into sustainable ones.

WikiQuESD applications are being designed to use multimedia (images, text and sound), various mind tools and open education learning objects to promote collaboration, connectivity, "real-world" learning-based change, and systems thinking. All of these are emerging as key pedagogical methods conducive to education for sustainability. Within the 5 years of integrating the WikiQuESD platform into undergraduate courses dealing with sustainability issues, more than 200 assignments have been developed, which are uploaded in the Web. Themes developed in the project works dealt with types of energy, desertification, renewal resources, over consumption, bioclimatic schools and climate change. The content of the WikiQuESD projects submitted was inter-disciplinary and largely built on multimodal open education resources available in the Web. To ensure that content is authentic and learning is meaningful, pre-service teachers participated in developing WikiQuESD learning applications are encouraged to select and/or negotiate an ESD local/global topic and engage in learning tasks which are real-world and situated within realistic contexts. Assessment results show that course participants' instructional design models elicited at the beginning, in the middle and at the end of the course changed significantly. The shift to an alternative instructional design model was evidenced in the middle of the course when participants were asked to present the progression of their projects tasks. By the end, almost all WikiQuESD projects developed can be characterised by the following design characteristics: recursive, non-linear; learning objectives are negotiated (emerge through activation and learning processes); didactic material is constructed and re-constructed based on OERs; instruction focuses on contextual and meaningful learning.

Analyzing the content of the WikiQuESD projects submitted at the end of the course, it is evident that ICTs when merged with sound pedagogical principles may contribute to education for sustainability. Besides the learning outcomes gained while developing these projects, they can also be seen as good examples of curriculum innovation and evidence of changing their instructional design roles. Rethinking and revising education to address the knowledge, skills, perspectives and values related to sustainability is of paramount importance to current and future societies. This implies a review of existing curricula in terms of

their objectives and content with the aim to develop interdisciplinary and cross-disciplinary understanding and knowledge of social, cultural, economic and environmental sustainability. It is also worth pointing out that participants learned how to construct knowledge rather than acquiring knowledge.

It was also revealed by more than half of them that the knowledge and skills acquired through the WikiQuESD projects could be transferred to other situations. Looking into the WikiQuESD projects, it is also evidenced that participants used a mixture of assessment tools such as concept mapping, weblogs, and interactive exercises. Evidence through focus group discussions shows that the paradigm shifts have been empowered by discussions on the three dominant paradigms of learning (transmissive, transactual and transformative) in the context of the three corresponding models of curriculum: (1) product; (2) process and (3) praxis (c.f. Grundy 1987).

7.5 Concluding Remarks

Three of the major forces shaping and driving the 21st century education are (Makrakis 2008): (1) the development and diffusion of Information and Communication Technologies (ICTs); (2) the increasing demand for new educational approaches and pedagogies that foster transformative and lifelong learning and (3) the reorientation of educational curricula to address sustainable development (SD). This Chapter examined the role of ICTs as enabling transformative tools in advancing education for sustainability. It is important to point out that within the ICT as enabling transformative tools concept the process rather than the end product is central to their function for capacity building, advocacy, empowerment and emancipation. Merged with critical pedagogy, ICTs may enable learners to not only engage in active citizenship with their local communities, but also to participate in collaborative inquiry and discourse with other people. There is evidence to suggest that learning environments that enable reflection utilizing ICTs helps in challenging established values, norms and practices. This process can be very empowering, enabling all participants to take action to tackle sustainability problems and also to communicate their needs and ideas to decision-makers and/or other groups in their local communities. While increasing the quality of basic education through ESD, the use of ICTs pose many challenges for innovative and creative ways in reorienting teacher education to address sustainability. From the examples presented here, it is clear that building constructivist learning environments enabled by ICTs has an important influence on the pre-service teachers' learning both in terms of what and how to teach. Based on the students' personal accounts, journal entries, reflective essays and ICT-enabled projects developed dealing with sustainability, their perspective transformation was empowered. This was more evidenced through their learning preparations, shifts towards teaching methods conducive to sustainability education, choice of themes and learning activities, investigative practices applied as well as the way they were seeing themselves and the world.

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Part II
ICT in Technical and Vocational Education

Chapter 8
Pattern-Based Approaches to Introducing New Technologies in Vocational Training

Alke Martens, Nils Malzahn and H. Ulrich Hoppe

Abstract Vocational training is much more dependent on external factors and thus much less self-contained than education and instruction in general public schools. Based on experience gathered in recent projects, the potential of using innovative web-based technologies to support teachers and students in this complex situation are illustrated and discussed. As for the technologies, the focus is on web 2.0 approaches, thus facilitating the creation and sharing of content on the part teachers and learners. From an educational design point of view, a special focus is the support of teachers through "pedagogical patterns" accompanied by empowering them to better manage and share web resources in their teaching. Issues of organizational culture and change management turn out to be decisive for the success of such approaches.

Keywords CSCL · Web2.0 · Educational patterns · Learning analytics · Network analysis

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R. Huang et al. (eds.), *ICT in Education in Global Context*,
Lecture Notes in Educational Technology, DOI: 10.1007/978-3-662-43927-2_8

8.1 Introduction

Web 2.0—this comparably new buzzword stands for a plethora of different software approaches, all of which are related in some way to involve users in the creation of web content. What comes hand in hand with this development is a fast growing amount of information available and a potential change in the quality of the information. More than ever before, young people have to learn how to treat "information" related aspects: information acquisition, information evaluation, laws related to information publication, and different forms of networking (e.g., based on social networks, including cooperation, collaboration, and communication). This is true for school kids—but as well for people in vocational or on-the-job training. Teenagers often adapt smoothly adapt to the new forms of communication and they accept a kind of unrestrained personal availability and visibility of private life (even if they are often ignorant to the dangers). It is observable, that people who have not grown up in the web 2.0 world have to overcome different obstacles, based on established and unflexible working traditions and routines, up to personal fears. A comparably easy way to help people to work with modern technology would be to integrate the usage of this technology (like web 2.0) in everyday classroom settings, and thus to train how to treat information related aspects (evaluation, publication, sharing, communication, and the like). However, teachers (in schools and also in vocational training) have also grown up in a pre-web 2.0 world. They are not able to integrate the new technology and they often lack the time, the knowledge and the courage to develop new instructional concepts with the available tools. Seldom approaches can be found where schools use wikis. More often schools have their own tools for information spreading, like content- or learning-management-systems. Education based on web 2.0 technology, using the underlying information related concepts and networking ideas, is in most cases a topic of single individuals, i.e., teachers who are especially interested in the computer science or information technology (Richardson 2010; Schwenk 2008). The general topic "Information and Communication Technology" (ICT) could be incorporated into several school subjects—however, this has not taken place yet (Harrer and Martens 2010; SVEA 2010), even if a search for application domains in the context of school and vocational education is taking place since a few years (SVEA 2010).

In the following, two approaches will be sketched as examples of how web 2.0 technologies and related concepts for treating information can be integrated in vocational training and on-the-job training. The two experiences address different target groups: In Experience 1, we have a mixture of comparably young students in vocational training, who have a technology oriented background, and thus potentially have experiences in web 2.0 prior to the training at school. We also have teachers at the vocational school, which in Germany have very different backgrounds, e.g., law, business, but also computer science (all at university degree level). In Experience 2, we find a scenario in which employees of an industrial partner in the German food industry are trained based on web 2.0. Here the overall goal was to enhance interest of the mostly low qualified persons in vocational training to raise their qualification level.

Both projects have been funded by the BMBF—Federal Ministry of Education and Research in Germany, and the ESF—European Social Fund.

8.2 Experience 1: Web 2.0 in Vocational School: Instructional Design, Example, and Evaluation

The first experience sketched in this section is related to teaching and training at a vocational school in an urban area. The teachers have different backgrounds; in most cases, they have had no computer science education. The students will finish their education as computer technicians, thus they should have more knowledge (or at least no fear) of information technology in general and web 2.0 in particular. The project, called India Web 2.0, has been developed by three partners: The University of Rostock, Institute of Computer Science, brought their expertise in web 2.0 technologies and additional in computer science education and instructional design. The company ANOVA developed software solutions especially suited for the vocational school and the special form of training, and the IT College Putbus represents the target group and worked hand in hand with the other two partners regarding the development of content, instructional design, and software. Result of this project has been a three-layer approach:

Layer one: A collection of instructional methods has been developed for a set of web 2.0 technologies. Based on the insights provided by prior work in pattern design and pattern catalogues, a catalogue of instructional methods for web 2.0 based educations has been developed. The abstract patterns for developing a lesson (or a session) based on web 2.0 will be sketched in the following subsection, extended by an example.

Layer two: An exemplary software solution has been developed to suit the special needs of classroom settings. Even if there are some interesting aspects, like privacy and security, the developed software is not in the focus of this paper, as the above-mentioned methods are not dependent on special software solution.

Layer three: All layer one methods have been tried in the classroom, in "real life education." Thus, it has been very important to accompany the project with an empirical study. Phase one of the study investigated the initial state, i.e., the prior knowledge of students and teachers, their knowledge same as their fears and prejudices given the web 2.0 topic in school education. Phase two investigated the application of the methods, including a spiral approach, where methods and underlying pattern are adapted to the finding. Last but not least, phase three also took place at runtime of the three-year project. This phase was used to find out something about potential (short term) effects of applying web 2.0 method in the target groups.

8.2.1 Catalog of Instructional Methods

The catalog of instructional methods has been developed based on two basic ideas. The first idea is rooted in instructional design and in the fundamental assumption that education (i.e., lessons) shall be designed based on instructional

insights. Instructional science has the goal to develop a deeper understanding of the instructional process and the related resulting learning, thereby combining insights from theory and practice. In Germany, the notions of "didactics" or "didactical design" (see e.g., Jank and Meyer 1991) are common denominators for instructional science. In this tradition, didactics may even be limited to curriculum design (focusing on the selction of content matters) and thus distinguished from the methodology of instructional design (i.e., how to teach) (Jank and Meyer 1991). In this sense, the following catalog is a collection of instructional methods, providing concepts for instruction in form of suggestions and examples, which have been tried and applied in reality. The second fundamental idea of the described approach is deeply rooted in state-of-the-art computer science: for describing the instructional methods, patterns have been used. The idea of developing patterns as a form of boundary objects (Martens et al. 2009) for facilitating communication between groups of people with different technical languages can be traced back to the architect Christopher Alexander (Alexander et al. 1977). The approach has been used to develop software patterns in the 1980s and eLearning patterns in the late 1990s (Harrer and Martens 2010). The collection of methods use patterns in two ways: the description of a method itself is provided in form of a pattern and the collection of instructional method patterns forms a pattern catalog. The catalog's structure can be seen in the following picture (Fig. 8.1).

We distinguish between abstract base methods and concrete methods. Abstract base methods (all having the same content structure) can be reused in different settings for developing instructional entities. Concrete methods provide application examples, which have (at least partly) been tested in instructional settings at

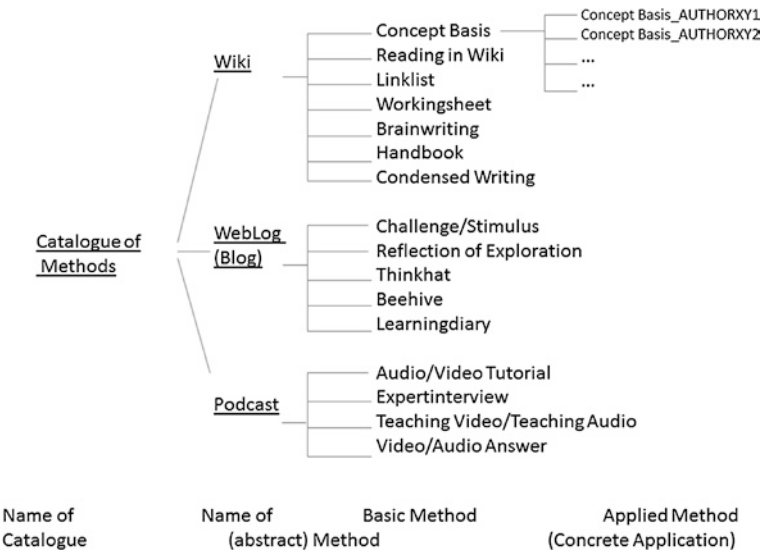

Fig. 8.1 Catalogue of instructional methods

school. The catalog of methods and several application examples can be found at http://methoden.fachinformatik-online.de. The base methods are taken and adapted from classical literature for lesson preparation and instructional design, e.g., (Jank and Meyer 1991).

A single base method consists of the following base items:

1. Attributes of a method: containing a short sketch of the method and the underlying web 2.0 tool. Additionally, some basic properties will be given, e.g., name of the developer, competencies of the students, learning goal, additional information like related literature or links.
2. Course of action in the instructional entity (e.g., lesson): here prototypical processes and timelines will be sketched
3. Preparation of an instructional entity: this item provides information for teachers who will prepare a lesson based on the method. Aspects like time, resources, digital media (Meyer 1993) are given. Additional material can be attached (e.g., alternative lesson structures, handouts, or information material).
4. Experiences: teachers can use this point to make a documentation of their experiences while using this method. The collection of experiences and opinions can help other teachers when re-using this method.

These base items are also a part of the concrete methods, but each item is related to concrete information about a certain web 2.0 method. Additionally, teachers can modify or extend all the prepared contents as well, thus developing their individual instructional method.

Related to the catalog of methods is also intended to develop a teacher network, where teachers can exchange experiences with using the new methods in their classrooms and where they can upload and download concrete instructional methods and descriptions, and thus over the time develop a fund of instructional method and experiences.

8.2.2 Example of a Base Method: Wiki for Handbooks

In Fig. 8.2, an example of a base method can be seen. The sketched method is a base method, as in the table concrete entries in field of instruction, topic, learning content, used instructional material, and experiences are missing. In concrete methods, these fields must provide entries.

The sketched example uses the web 2.0 technology “wiki” in a class where the students shall cooperatively and over the semester develop a handbook for a certain (in our target group: computer science) topic.

Next to the classical identifiers, like name of author, institution, username, and version, the field competency class of the method is of special interest. Here, the profile of the base competencies can be found. These are not the competencies which can be checked in the course of instruction, but they offer the teacher a first orientation. Similarly, the items learning target, goals, and value sketch what a

Author, School, Username	Dr. Test, Testschool, TTTest001
Version of Method	1.0
Short Title	**Wiki Handbook**
Title	Wiki-based Development of a Handbook
Competence related to Class of Method	Communication und Cooperation
Kind of used Social Software	Wiki
Field of Learning	*(Entry would be part of concrete method!)*
Subject (in Class)	*(Entry would be part of concrete method!)*
Learning Content	*(Entry would be part of concrete method!)*
Short Description	Use a wiki in classroom settings to train technical documentation based on wiki
Description / Advance	In most cases, technical documentation is complex. The usage of a wiki for documentation purposes enhances a structured approach and interaction and exchange in teams of technical writers. Part of the documentation are usually items like: parts of the system and their functionality, maintenance, business process models, etc. In classroom settings, the wiki structure and the wiki content shall be developed by teams of developers over a longer time (e.g. a semester). The resulting system can continuously grow over time and be re-visited and re-structured by all participants / students. Wiki development is part of knowledge management and should be trained as such. Tasks of the teacher could be: * Introduction and explanation of the method * Content and content structure preparation (or: part of the content / content structure) * Motivation thoughout the semester, initiation of the discussion phase * Summary, final discussion, feedback Tasks of the learners could be: * Participation in the introduction phase and in the final phase * Development of content / content structure * Team interaction * Commenting entries in the wiki, re-vision of entries, commenting comments etc. * Documentation of experiences Tasks of all participants: * Discussion of Wiki usage for handbook development and discussion of content

Learning goal / Target / Benefit	* Practical usage of Wiki technology for handbook development * Working as technical writer / developing technical documentation * Active knowlege management * Developing text in teams * Learn how to document own experiences * Learn how to provide feedback
Target Group	Size: min: 1, max: 25 (Group learning) Special education: Background knoweldge in Wiki terminology is helpful. If the learners don't have this background knoweldge, the teacher must extend the introductory phase and offer additional material (Note: the terminology is not very complex and comparably easy to learn)
Preparation and Time	Preparation: * Establish a Wiki at the school's computernetwork (or test it if it is available) * Write first test structure (e.g. for demonstration purposes) of a Wiki handbook for a technical system Time needed during education: * Introductory phase for preparing the students * Closing phase for final discussions and feedback * Intermediate phases for feedback and for checking the „behaviour" of students in the wiki discussions" * Time needed for „everyday" / continuous work with the wiki over the semester
Required Technical Equipment	* Wiki Software * Internet for every user
Required Teaching and Training Material	*(Entry would be part of concrete method!)*
References, Related Literature, Real Life Examples	*(Entry would be part of concrete method!)*
See also / similar methods / Synonymes	*(Entry would be part of concrete method!)*
Experiences with this method, hints for other teachers / Further knowledge	

Fig. 8.2 Example base method: wiki handbook

learner potentially can be able to reach by using this method. In the example, i.e., using wiki for a handbook, the competency class of the method is communication and cooperation, as the group of students should cooperatively and over a longer period of time fill in entries in a handbook based on a wiki structure. Using other wiki gadgets, like discussion, critique, and the like, communication between groups is forced. Learning targets are thus not only using the wiki and cooperatively writing content (including structuring and recording own knowledge), but also to evaluate text parts, to make suggestions for improvement, and how to communicate (in written text) feedback in a goal-oriented and positive way. The item description, course of action shall help teachers, who usually have only little to no knowledge about using web 2.0 in education, to envision an instructional scenario. In the example, details about using wiki for handbook generation are given and additional coarse information about the general tasks of teacher and learner in a classroom scenario. Learning goals and general goals related to the example are for example "learn how to use a complex system in real life, learn how to record and document, learn how to communicate and collaborate in working processes." Especially helpful is also information about the target group, and at which size of the group the sketched instructional method is useful. In the example, it has been observed that the group size should best be restricted to 25 persons. Basic competence of the participating students is prior knowledge in how to work with a wiki. Central information is given in the item technical equipment, including hardware and software—in the example a wiki software and internet access for teachers and students for research and information acquisition. In the example, the communication in the smaller working groups is realized offline and life, thus the complete group is split into smaller teams that cooperate directly. In later phases of the teaching and training sessions, the whole class of students works together and online directly in the wiki (e.g., in the context of providing feedback and suggestions for improvement). Last but not least, teachers always find information valuable regarding the duration and the tasks of the preparatory work. In the wiki example, this includes for example in the preparation phase: select a wiki, provide a prior structure for the students regarding the educational content. In the execution phase, the teacher must take care to first inform the students about the tool's properties before letting them work, and to prepare special learning phases in the lessons, so that students have time to develop, comment, and change entries in the wiki handbook.

8.2.3 Use Case: Wiki Handbook Method in an Instructional Unit: Wiki Glossary

Based on the above-mentioned based method, a concrete classroom scenario will be described: A group of students, who visit the vocational school to become system engineers, develops a wiki glossary for a given set of terms, which are provided by the teacher. Terms in the instructional unit "technical informatics" are for example: Flip-flop, finite automaton, control unit, etc. The students' tasks

are: to develop a wiki structure, to develop wiki items for definition of the terms, relation of the terms, classification, and the like. The students have to collaborate in the development process, i.e., there are several smaller groups for a set of items to develop the wiki entries, and later all entries are evaluated and commented in wiki discussions by all groups. The instructional unit is separated into several phases. In the first phase, the introductory unit, the teacher uses 45 min to explain general wiki aspects, to exemplarily show item structures in a wiki, and to discuss first insights about item structures—also based on examples. After that it was planned that students should construct their own wiki structures and feed content into this structure for the first half of the semester, and that discussions, feedback and revision of the entries should take place the last half of the semester. In reality, students have used approximately 8 × 45 min to feed new items into the wiki glossary, to discuss the items, and to correct them. An evaluation of the student activity showed that unfortunately the process did not take place at the runtime of the semester. 93 % of the entries have been developed in 2 days. This showed mainly that teachers have not had enough routine to smoothly integrate the concept into their semester as a re-occurring task.

8.2.4 Evaluation and Insights of Experience 1

The project India Web 2.0 has been evaluated based on data acquired by three steps:

1. Structured (guideline) interviews
2. Lesson monitoring and evaluation of online activities of the participants
3. Online questionnaires (based on the system EvaSys, anonymized and without usage of private email addresses, as the login data have been given to the participants on-site).

The data have been evaluated qualitatively and quantitatively. The evaluation took place in three phases: initially, before runtime of the project (state of the art analysis), continuously at runtime (formative analysis), and at the end of the project (summative analysis).

Participants are the teachers and students at the vocational school IT College Putbus. The teachers have a very heterogeneous profile, as in Germany teacher at the vocational school do not necessarily have a teacher educational background. For example, some teachers have University degrees as Computer Scientists or as Jurist. The students are all from the background “Fachinformatiker”, which is comparable to IT Application Specialist.

The Evaluation was conducted based on three major questions:

1. Usually in vocational school the motivation and the self- learning competence of the students are comparably low (Euler et al. 2004). To enhance the ability for life-long learning is a nice-to-have, but seldom found in real life education at vocational schools. Can this be confirmed by the evaluation in the target group?

2. Can the problems regarding motivation and self-learning competency be solved by using web 2.0 concepts in education? Are there reasons, which can be fixed?
3. Are there new problems, which arise due to the usage of the new web 2.0 technology?

The investigation took place with $n = 150$ students, most in the age between 16 and 32 years, 15 % females ($n = 23$). Forty-four percentage of the students usually learn alone at home ($n = 66$, where 94 % only try to memorize things, instead of developing real understanding), 35 % partly alone and partly with friends, and only 21 % work only in teams or working groups. Given the last two groups, at least 35 % of them try to develop a "real understanding" of things, 77 % of them use additional information found in the internet. Of all students ($n = 150$) 70 % work in social networks on a daily basis, 59 % use chat systems daily, and 82 % use the wiki at least once a week. These findings are compliant with the Bitkom user study 2012 (BITKOM Bildungsklick 2012).

Regarding the expectations and their opinion about using web 2.0 in education, 57 % of the participants state that classical education should be modernized and that they expect to have web 2.0 method integrated in everyday education in school.

In the group of the teachers are $n = 15$ participants, 93 % of them no teachers in a classical university teacher education but from other professional background (so-called career-changer). Sixty percentage of the teacher have no prior knowledge in web 2.0 technology, 40 % would call themselves "mere users". The instruction used by all of them in most cases is "ex-cathedra teaching", 87 % have no planned interaction in their lessons, 73 % offer text scripts, and 47 % use work sheets for homework. Most of them use the internet, even in lessons (93 %), but only to show and to demonstrate things.

The overall evaluation at the end of the project showed the following (shortly sketched):

Most of the teachers stated in interviews that the methods influenced their instructional design in a positive way, and that the catalogue of methods gave them the possibility to think instruction in a new way. They observed that even weaker students have shown more interest.

The students have criticized the approach much more: only 23 % found the lessons with web 2.0 more interesting than the classical lessons, 40 % are indifferent. Distinctly "very good" was given by only 3 % and "not good" by only 14 %. So students generally seem to have weaker interest in the new instructional design than teachers, which was surprising. But a closer look at the resulting data revealed that the students critique was primarily the "not very smooth integration" of the new technology in the instructional design of the lesson. After all, this resulted in the insight that student nowadays expect teachers to integrate web 2.0 and other modern interaction, communication, and collaboration technology in their education, but it has to take place in a more natural way. Students felt that the teachers have had a comparably low motivation to use web 2.0 technology, that they have not been active and involved as partners in the educational process, and

that required information (e.g., about data security, especially regarding personal data) has not been given by the teachers.

Regarding the questions sketched above, the results are:

1. The students participating in this study have the same problems regarding motivation and self-learning competency as expected based on comparable studies.
2. The answer to this question is a bit tricky. Shortly, a web 2.0 technology alone integrated into the instructional design is not enough to enhance anything. However, the methods developed in the projects have had another effect: the teachers started to re-work their lessons and this resulted in a more interactive style, which led to more motivation on the side of the students. Here is the point to continue and one resulting insight: the new technology, summarized under the term web 2.0, is mainly focused around topics like: interaction, communication, collaboration. These tasks are part of the students' everyday life and this will be even more true for the next generations. However, this is not (yet?) part of the teachers' lives. If instruction changes, based on web 2.0 or not, it should change toward more interaction, communication and collaboration between teachers and students (and also between teachers). Tools to support this can be found in the web 2.0 world. Methods to support such instructional designs have been developed and will be extended in future work. This is also reflected by experience 2, which will be sketched in in Sect. 8.3.
3. New problems arise mainly in fields like protection of private data, data storage, publication of data and the like. Another problem area, which is admittedly not new, is teacher education: as teachers are the weakest part in this scenario, a good vocational training for teachers has to be a necessary first step before integrating new tools.

8.3 Experience 2: Web 2.0 in Vocational Training: Instructional Design, Example and Insights

The food industry in Germany is characterized by a high amount of workers without or with only a low level of formal qualification. While these workers are easily found and taught to perform simple and often physically exhaustive tasks, there is a lack of employees with a higher qualification (e.g., skilled workers), who are able to use and control the complex machines and processes of the food production industry. Thus, human resource managers try to train some of the lowly qualified workers to a higher qualification level to close the gap. This is not an easy task as these workers often have a migration background and ensuing language problems and/or they are not very motivated to learn because of various reasons, e.g., education is not an asset to them or their work is so exhausting that they are not ready to learn after work.

In this context, the project FoodWeb2.0 (funded by the German Ministry of Research and Education) aims at training the employees of the German

food industry using two basic strategies: Motivating employees for vocational training and performing education in collaborative, blended learning using Web2.0 technologies. We propose this approach, because we think that Web2.0 tools offer appropriate support for collaborative learning activities that support the development of valuable competences and skills with respect to their workplace requirements.

Furthermore, Web2.0 tools implicitly contain functionalities that provide gratifications through media usage (Katzet al. 1973) by addressing relevant user needs. These needs comprise several informational, entertainment or social aspects (Bonds-Raacke and Raacke 2010; Haferkamp and Krämer 2010) that are also relevant for learning processes and motivation (e.g., social comparison, gamification, and social feedback). Thus, the use of Web2.0 technologies (e.g., profile pages, rating systems) may increase the learners' motivation for learning.

8.3.1 Collaborative Learning Using a Web2.0 Platform

There are numerous studies that deal with the effect of collaborative learning on learning outcomes and success. (Tannenberg 1995) found that collaborative learning is perceived as less tiring than other learning methods when learning process flows. (Kulik and Kulik 1979) found that collaborative learning increases the intrinsic motivation for the learning topic. Therefore, it is likely that the willingness to engage oneself in the learning topic after having finished the course and the motivation to participate in further trainings will increase. Since (Baird 1986) observed that collaborative learning encourages the learners to be responsible for their own learning, it is expected that the participants of a formal learning process will take part in other nonformal learning processes as well.

Many adult training courses are characterized by heterogeneous groups of learners. As collaborative learning promotes peer learning as one option (Cohen 1994), a collaborative learning approach helps to even the different skill levels during a course because students learn from each other and weaker student may profit from the knowledge of skilled learners within the course. Additionally, collaborative learning encourages the acquisition of desired social (Breen 1981) and leadership skills (Johnson and Johnson 1990). Thus, collaborative learning is capable to improve the learning success of a wide variety of courses for diverse target groups.

Another problem is the short time spent at the training facility. Thus, the examples shown or the example processes experienced by the participants of such a course cannot represent the complexity of the real processes at the participants' workplaces. Hence, the participants experience difficulties in applying the newly acquired knowledge to their everyday work. Davidson (Davidson 1990) showed that collaborative learning may lead to a better simulation to the workplace situation, because it allows for a division of labor and therefore to work on more complex examples.

Last but not least, collaborative learning is known (Tinto 1997) to bring forward stable groups of learners or even learning communities. This helps to sustain a learning process even after a course finishes, because trust built during the initial collaborative learning process is transferred to subsequent situations at the workplace. Thus, workplace problems are discussed within the learning group, stimulating informal learning.

In summary, the usage of collaborative learning methods is expected to have positive effects on learning outcomes and its respective results. It has been show that these effects are also achieved in computer supported settings (Lehtinen et al. 1999).

The philosophy of Web2.0, including user-generated content, collaboration on artifacts, as well as mutual sharing of artifacts and knowledge, fits well with basic idea of collaborative learning. Thus, using Web2.0 tools to leverage the advantages of CSCL in the food industry seems promising. Hence, we set up a Web2.0 learning platform (see Fig. 8.3). King's classification of learning (King et al. 2001), which distinguishes instruction (goal-oriented, formal instruction), explorative learning (goal-oriented, informal), and serendipity learning (without a goal, exploring, informal) fits well with the idea of learning on Web2.0 platforms. While traditional e-learning1.0 is almost completely based on instructional learning, where content is just consumed by the learners, explorative learning (King et al. 2001) demands that the learners navigate through the learning content on their own. That means that the learners should be able to move through the content outside the limits of a single course or lesson to satisfy their learning needs. In this case, serendipity learning is a piggyback effect, since the typical Web2.0 link collections (either tagged or otherwise indexed) often provide the opportunity of discovering an interesting bit of information by chance.

The FoodWeb2.0 project provides a platform for all three types of learning as well as the opportunity to create a PLE. Every contribution on the platform may be tagged, commented and rated depending on the configuration by the creator of an artifact, by a teacher (for respective courses) or the site administrators. There are several possibilities to aggregate collections of contributions depending on their affiliation to a course, a topic or the artifact's type (article, blog, wiki, video, file, image, forum, etc.). Furthermore, the basic platform system (Liferay Portal) allows for the configuration of a personal area that may be used as a PLE. Site-wide provided templates for reasonable tool combinations help beginners to create their own PLE: Thus, the FoodWeb2.0 platform provides a complete environment for Web2.0 learning.

8.3.2 Case Study: A Course About Web2.0

The course teaches basic knowledge about using Web2.0 tools and good practices (privacy, intellectual property, "friendship", etc.) on the Internet in general. The basic structure of every lecture consists of introductory media (text, video, images)

Fig. 8.3 Snapshot of a course on the FoodWeb2.0 platform

provided by a teacher, followed by task descriptions asking the participants to create contributions (images, videos, text). These contributions vary from comments and forum posts with respect to "central questions" in the beginning to collaborative work in small groups within a wiki (Jigsaw design (Aronson and Patnoe 2011)) in the later phases of the course. Furthermore, the course uses WebQuests (Dodge 2001) to motivate the learners to explore important topics of the course and share their acquired knowledge with each other.

Thus, the participants are getting to know (and to use) the Web2.0 tools step-by-step while learning about important topics with respect to the Web2.0 in general.

As the course participants were distributed all over Germany, the course was conducted completely over the Internet, framed by two video conferences: a kick-off meeting, where the basic platform functions (logging in, navigating through the course content etc.) were explained and a feedback meeting after the final

exam, where the participants were asked to give feedback and tell about their experiences with this type of course, which was new for them. If the final exam was passed, a certificate of successful participation was issued.

We conducted two runs of the course. The first run (A, 14 learners) was conducted with regular employees of the German food industry. The second run (B, 13 learners) was conducted with persons teaching in current trainings for the German food industry. Thus, we are able to compare the behavior and performance of employees and the teachers in this industry branch when confronted with Web2.0 learning (Malzahn et al. 2013).

Performance. The overall performance in both courses in terms of number of contributions to the course and successful final exams is almost the same. The slight difference in the overall contribution amounts (see Fig. 8.4) can be explained by the different amount of participants. The amount of static, instructor generated content (article) is the same in both courses.

With regard to positive issues, participants in both courses mentioned similar aspects: the combination of theoretical aspects and practical applications (and sufficient support from course instructors. Additionally, two participants from course A addressed the issue that the course allowed for flexibility regarding working hours).

The aspects participants liked least about the courses differed between groups: In both courses, people addressed problems in collaboration. But while in one course these problems were assigned to differences caused by the participants' heterogeneous prior knowledge in other courses the participants criticized the type of assignments as a potential cause. Consequently, they found the assignments unrewarding and had the feeling that they did not allow for knowledge transfer.

Learning. Participants in both courses were asked (open-ended) which aspects they found most helpful for learning. They addressed the benefits of a practical application of learned content, building upon contributions by other participants

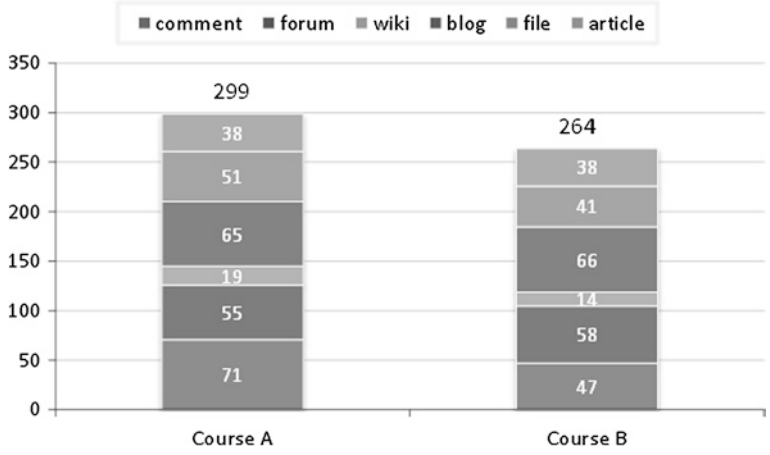

Fig. 8.4 Distribution of artifacts among two different courses

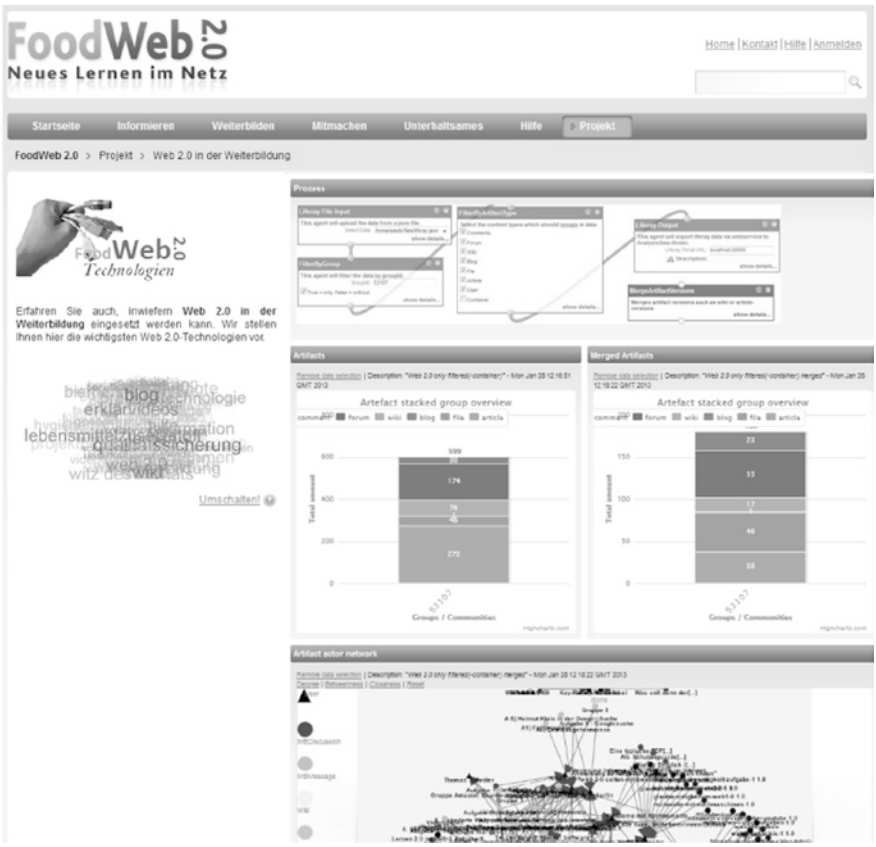

Fig. 8.5 Snapshot of the analysis cockpit integrated into the FoodWeb2.0 platform

as well as the possibility to explore a topic. Other participants simply liked the provided information (e.g., texts, links).

Collaboration. Overall, the participants' impression of collaboration was positive, but mixed with mixed feelings toward collaboration as a motivational factor as some of the participants felt that they were not part of their respective group. They even believed that individual learning would have been better.

The perceived collaboration can be contrasted to the observed artifact interaction of the participants within the analysis toolbox (see Fig. 8.5) provided to the teachers on the FoodWeb2.0 platform.

Figure 8.6 shows the results of a degree-based analysis of the interaction. The first row shows the interaction in course A. The second row shows the results from course B. The left column shows the resulting collaboration network including the teachers (in the blue ellipsis). The right column shows the same network without the interaction with the course instructors. The size of the triangles representing the members of the course indicates the degree (a basic network analysis measure)

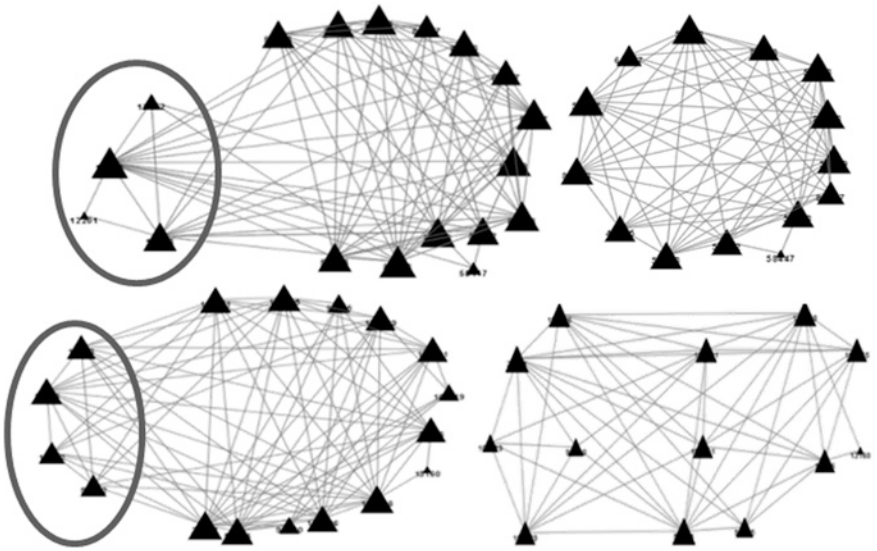

Fig. 8.6 Collaboration between participants with (*left*) and without teachers (*right*) (A above B) as logged by the system

the respective node. A higher degree results in a bigger triangle. The size increases logarithmically to emphasize the order of difference.

The network analysis results show that the fragmentation of the group as perceived some of the learners of course B cannot be validated by the actual interaction. In both courses, the participants interact directly with each other. The networks do not fall apart when the course instructors are removed from the network. Nonetheless, the density of network A (0,71) is higher than the density of network B (0,64), which indicates a slightly tighter cooperation.

8.3.3 Insights

The participants of course B were less satisfied with the course than the ones of course A. They found the approach of exploring topics on their own (in groups) less helpful for learning than participants in group A. Further results (Malzahn et al. 2013) indicate that course B would have preferred to work individually and to be provided only with the necessary information to work on the assignments. Consequently, group B contributed fewer comments on the work of others (see Fig. 8.6). Not all participants shared the same negative view (Malzahn et al. 2013), but that some participants were more involved in group work than others as can be seen from Fig. 8.6. While the magnitude of interaction per participant (size of triangle) in course A was almost the same for all participants (Fig. 8.6; upper

right network), the size (based on a logarithmic scale) of the triangles in course B indicates bigger differences between the respective participants. This correlates to Swan's findings (Swan 2001) which states: "Students reported high levels of interaction with their classmates also reported higher levels of satisfaction and higher levels of learning from course."

Since the general topic of the course is Web2.0, the course instructors used a lot of the Web2.0 tools offered by the FoodWeb2.0 platform. In turn they also asked the participants to use these tools giving clear instructions on how to do so. The participants used all of the tools as demanded and expected to solve the given tasks, but the use of forums and blogs were preferred over wikis and videos.

The average uptake of the course's contents as well as the solutions to the given tasks was generally good. Of course, some of the participants needed more time than the average participant and others needed less to accomplish a given task, but from a teacher's point of view both courses were considered successful. The notion that the participants spent additional time on the provided information, as they valued this information, supports the hypothesis that Web2.0 learning is capable of initiating informal learning processes and increases the students' interest in the covered topics.

8.4 Discussion and Conclusions

Example 1 exemplifies an approach to develop and integrate Web 2.0 methods in classical classroom settings in vocational training. Example 2 demonstrated an approach to integrate Web 2.0 technology on on-the-job training. In the first example, the stakeholders are teachers at a vocational school and students at this school. Main education direction of the students is computer science, thus prior knowledge about web 2.0 technology can be presupposed. In the second example, neither teachers nor learners must have prior knowledge in Web 2.0. Either way, in both examples the integration of Web 2.0 or of Web 2.0 technology leads to a change of the instructional structure of the courses, away from ex-cathedra teaching, toward interaction between all participants (including teachers). This effect could also have been reached without Web 2.0, e.g., by teachers re-thinking their instructional course design. Nonetheless, there are some aspects, which led to the insight that also the integration of Web 2.0 tools and methods can enhance instructional design and support learning processes.

8.4.1 Ingredients of Successful Courses Using Web2.0 Tools

Although the general attitude toward Web2.0 learning, collaborative learning and online learning as well as prior experience with online learning does not indicate a considerable difference between the teachers on the platform (Malzahn et al. 2013), the success of the courses with respect to motivation of students and implementation of Web2.0 learning (or just collaborative learning) varied.

While some of the teachers have successfully implemented a Web2.0 blended learning course others were not able to conduct an online course with considerable participation of the students (example 2). Similar experiences have been made in example 1: not all the teachers have been able to integrate Web 2.0 methods in their everyday education in a way that supports learning processes. The evaluation revealed that students are sensitive regarding the course design: if they notice that the teacher has reservations about the introduction of an innovation, the students are very likely to develop reservations as well.

Both observations confirm that (Web 2.0) technology as a sole motivational aspect of a course is not sufficient. In addtion, the introduction of new tools should be linked to content-rich tasks to motivate the use of the tools and force the participants to deal with it. Moreover, on-the-job training for teachers is very important. Only if the teacher are feeling confident about the applied method or the used tool, they can develop a motivating and supportive learning design. This has also been observed by other researchers:

As Krajcik et al. (1994) point out, the teachers need to be supported, because the difficulties they may encounter will otherwise hinder the adoption of a new approach. One example of such a difficulty is formulating an appropriate task for the students to elaborate on (Krajcik et al. 1994). Ladewski et al. (1994) found further dilemmas that interfere with the introduction of new pedagogical approaches like beliefs in efficient and effective teaching by teacher directed activities and information dissemination in contrast to student's self-responsible learning and information sifting. Tightly connect to this issue is the worry about student's which do not obtain the "correct" results (Ladewski et al. 1994).

Marx et al. (1997) also indicate that even if the teachers change their teaching strategies they tend to focus on one or two aspects of a new approach. This may or may not be sufficient, depending on the selected aspects. Furthermore, "teachers tend to modify their practices in idiosyncratic ways, mapping new behaviors onto old behaviors and moving back and forth between old and new practices" (Marx et al. 1997).

To support the teachers in their adaptation processes, we have tried to identify best practices for successful Web2.0 courses, as has been done in experience 1, see Sect. 8.2.

The successful courses on the FoodWeb2.0 platform and the India Web project show that the use of pedagogical patterns (Eckstein et al. 2002) are generally a good indicator for successful courses, as other courses that ignored the motivational needs of the participants or even applied pedagogical anti-patterns (e.g., unclear task description, free choice of (Web2.0) tools, omitting introduction of the virtual classroom or the tools to be used) lead to unsuccessful courses.

One of the more successful patterns on the FoodWeb2.0 platform with regard to teacher and student acceptance was the use of WebQuests. This method is even able to ease the cold start problem, because the participants are asked to contribute additional content to initial set of provided material. Thus, a growing set of material is created with each course run. Even inexperienced participants are able to provide valuable contributions. The WebQuest pattern copes in a convenient way with the the teacher's belief in the importance of providing material and the effort needed to convert their material into online material. As the WebQuest preparatory

work basically consists of the collection of links to online material, which is related to the particular WebQuest task, there is a huge potential for re-using material that is already available online. The opportunity to ask the students to write down their findings (e.g., in a blog) for the presentation phase of this method, enables the teacher to assess the learning of the different groups. The students on the other hand, liked the opportunity to do some "research" themselves and the exercise of retrieving (work place) relevant information from the Internet as they found that this will be transferable to real world problems as well.

8.4.2 Organizational Context: Decision Makers

Organizational issues also have to be taken into account. We found in other studies was that the bigger institutions have more problems than the smaller ones. A regional study (SVEA 2010) found that educational institutions are reluctant to introduce Internet technologies into their courses because of missing media competence and Web2.0 experience at the decision maker level, which is often not assembled from teachers in vocational training facilities.

Thus, there is not only a problem of convincing the teachers, but of convincing the decision makers to relief their teachers to give them free time to adapt their courses to the new technologies. Consequently, teachers who already have some experience with these technologies are less concerned about the dangers of Web2.0 technologies, but they have a realistic estimation about the needed effort for the initial setup of an online course, whereas teachers with almost no experience are afraid of the technological dangers and overestimate the effort (building higher barriers), although both groups would try the new technologies if they had time.

If this time is organized by the decision makers, we may observe that the teachers recognize the added value of a teaching directed at digital collaboration within the course and cooperation with peer teachers. The perceived effort for the teachers and the students even decreases.

Some of the more advanced teachers even use some kind of KAIZEN-like quality control (Imai 1986) and continuing improvement process by standardizing their teaching processes and teaching material to enable a re-use of different modules in different courses.

In contrast to the success of motivated teachers in an adequate organizational context (paid) time for discussion, (paid) time for adaption, (paid) time to get to know the tools, a slot for tool introduction in curriculum of a course, teachers who are not properly prepared will result in students that do not (want to) use the tools or the platform.

Thus, it is important to focus on a proper preparation of the teachers at first. It seems reasonable to begin with a selected group of pilot teachers that are especially cared for. The transition from traditional classroom lectures to blended/online learning lectures should be as smooth and easy as possible.

In FoodWeb2.0, tools were provided that are capable of emulating PowerPoint presentations to re-use the available material as a starting point. Afterwards new tools and learning processes are introduced with the pilot teachers: step-by-step. These pilot teachers will show their success to their peers and the decision makers, so that a subtle process of convincing other teachers is triggered.

8.5 Outlook: Learning Analytics for Reflection and Awareness

As already mentioned above, the FoodWeb2.0 project provided a basic learning analytic tool kit to the teachers and decision makers, which allowed for a basic awareness about the overall activity in the courses for which the particular person is responsible either as a teacher or as a decision maker. In the project India Web 2.0, such a tool was not used, but we found the same in our monitoring of the lessons (video protocols).

According to Janneck and Janneck (2012), learning and especially collaborative learning can be seen as a communication process. Most of the modern teaching approaches try to move teacher-centered teaching strategies to collaboratively learning approaches as these come with several advantages according the competence development of the students (see Sects. 8.2 and 8.3). The communication processes within different teaching strategies are sketched in Fig. 8.7. The filled circles represent students and the unfilled circle represents a teacher. The direction of the arrows shows who communicates with whom.

From the perspective of both projects, a communication behavior like it is shown in Fig. 8.7c is ideal. The teacher moderates the learning process (e.g., helps to stay focused), but the teacher is not the gatekeeper of communication like in Fig. 8.7a. Furthermore, if the teacher is missing in Fig. 8.7a, the whole process will fail whereas in Fig. 8.7b and c the teacher may be eliminated from the process and there is at least a potential to learning.

Additionally, as stated above specific tools lead to a specific communication behavior. While blogs, forums, and wikis are often used in group (coordination) processes, static documents like html pages (called articles in FoodWeb2.0) and document files are usually only used by teachers to distribute information.

There are other more sophisticated measures, which may provide deeper insights into a specific learning process, but even those two measures provide a means for distinguishing potentially successful courses from those which are most likely to fail to incorporate collaboratively learning.

For example looking at Fig. 8.8: if the five teachers (encircled) did not have interacted with each other, there would not have been any interaction at all, which is a big difference to the example shown in Fig. 8.6, where the teachers (encircled) are just a part of the surrounding communication network.

The integration of such results into the FoodWeb2.0 platform as an analysis cockpit enables the teachers to reflect on the collaboration processes, and therefore

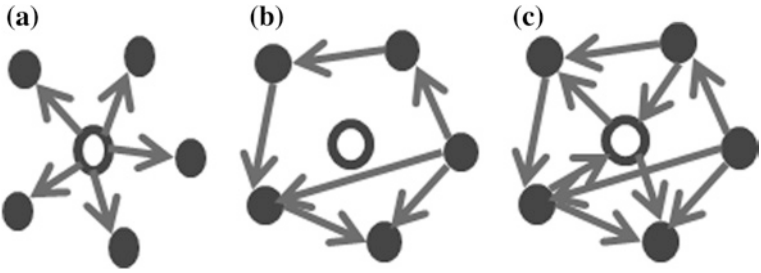

Fig. 8.7 **a** teacher-centered teaching (One-to-many), **b** group work (Many-to-Many), **c** teachers as moderators

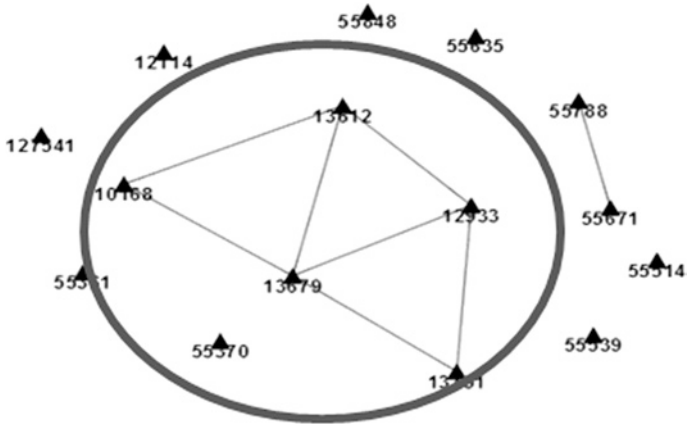

Fig. 8.8 Collaboration network of an unsatisfactory course: almost only the five teachers collaborate

provides the possibility to intervene. This would potentially also been helpful for teachers in the India Web 2.0 project. Of course such a cockpit could also be used by the decision makers of a (vocational) training facility to improve the overall performance of a particular institution with respect to organization specific best practices and human resource management.

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Chapter 9
Imperatives of Access, Equity and Quality in Indian Technical Education System: Role of ICT

Anup Kumar Ray

Abstract This paper analyzes available data to identify the causes of poor access, equity, and quality in the higher technical education system in India. It then proceeds to examine the effects of the policy measures taken to address these issues. Given the very inadequate intake capacity in higher technical education until around 2003, India's initial priority was to rapidly increase seat capacity, mostly through private participation. Access increased significantly but inadequately, mostly in affluent areas of the country and that too, more at the undergraduate rather than at the postgraduate level. Skewed increase in seat capacity in different regions meant that those who needed access the most lost out in favor of the more privileged and the urban rich, resulting in an increase in inequity. Since the capacity increase in technical education at the master's and doctoral levels were significantly lower than at the undergraduate level, the demand for qualified teachers far outstripped supply, resulting in a drastic loss of quality. In the meantime, experience from various pilot projects convinced India that innovative use of ICT tools was probably the best way forward. Three main priorities have emerged in the last decade: high quality e-content creation in the OER mode, massive increase in digital connectivity, and immediate development of versatile and cheap digital access devices. Large-scale teacher training through ICT tools and modernization of curricula are the other priorities. Major ICT initiatives undertaken in India in recent times are briefly reviewed, and it is concluded that given the socioeconomic realities, currently identified ICT priorities in education appear to be quite appropriate. Countries in similar position may benefit from the Indian experience.

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R. Huang et al. (eds.), *ICT in Education in Global Context*,
Lecture Notes in Educational Technology, DOI: 10.1007/978-3-662-43927-2_9

Abbreviations

AICTE	All India Council for Technical Education
BPO	Business Process Outsourcing
BRIC	Brazil, the Russian Federation, India, and China
CAL	Computer Aided Learning
C-DAC	Centre for Development of Advanced Computing
CIET	Central Institute for Educational Technology
DeitY	Department of Electronics and Information Technology
DTH	Direct to Home
EDUSAT	Educational Satellite
EMRC	Educational Media Research Centre
ERP	Enterprise Resource Planning
FOSS	Free and Open Source Software
GB	Giga Byte
Gbps	Giga bits per second
GER	Gross Enrollment Ratio
ICT	Information and Communication Technology
IGNOU	Indira Gandhi National Open University
IIIT	Indian Institute of Information Technology
IIM	Indian Institute of Management
IISc	Indian Institute of Science
IIT	Indian Institute of Technology
INR	Indian Rupee
IT	Information Technology
Kbps	Kilo bits per second
LAN	Local Area Network
LXDE	Lightweight X11 Desktop Environment
MHRD	Ministry of Human Resource and Development
MOOC	Massively Open Online Course
NASSCOM	National Association of Software and Service Companies
NBA	National Board of Accreditation
NCERT	National Council for Educational Research and Training
NE	North Eastern
NIT	National Institute of Technology
NITTTR	National Institute of Technical Teachers Training and Research
NKN	National Knowledge Commission
NPTEL	National Programme on Technology Enhanced Learning
OBC	Other Backward Classes
OECD	Organization for Economic Co-operation and Development
OER	Open Educational Resource
Oscad	Open Source Computer Aided Design
PG	Post Graduate
PPP	Public Private Partnership

RAM	Random Access Memory
R&D	Research and Development
SC	Scheduled Cast
SIET	State Institute for Educational Technology
ST	Scheduled Tribe
SWOT	Strengths, Weaknesses, Opportunities and Threats
UG	Under Graduate
UGC	University Grant Commission
UT	Union Territory
VCTEL	Virtual Centre for Technology Enhanced Learning
VOD	Video on Demand

9.1 Introduction

The need to provide easy and equal access to high quality, need-based education to every citizen is an important policy objective of most governments. Policy priorities on the use of ICT in education vary from country to country. Sparsely populated nations with citizens living in far flung places may emphasize on improving access; nations with a long history of social discrimination may consider equity as a higher priority. However, no nation can afford to ignore quality. A pragmatic policy must take into consideration national realities.

9.2 Overview of Indian Engineering Education System

9.2.1 Eligibility and Duration

Engineering degree programs in India are of 4 years' duration, undertaken typically at the age of 18, after completing 12 years of schooling. Admission to engineering degree programs often involves qualifying in additional competitive examinations.

9.2.2 Regulatory Framework

Both the State and Central Governments have jurisdiction on matters related to education. MHRD is the controlling ministry at the centre, and the highest regulatory body for technical education is AICTE. NBA, an independent authority from January 2010, is entrusted with the responsibility of accrediting all professional technical programs. The State Ministries of Education and the State Boards of Technical Education perform similar functions at the state levels.

9.2.3 Types of Engineering Institutions

There are three broad categories of institutions that offer programs of study at degree or higher level. Central institutions, funded by the Government of India, usually have the best standards. This is followed by the State institutions. Private institutions may be aided by the government or may be unaided. Although there are notable exceptions, in general, unaided private institutions enjoy the least reputation for quality education, and many are not even approved by the AICTE.

The IITs, IISC Bangalore, and a few other highly regarded institutions—perhaps around 20–25 in all—are usually called Tier I institutions for engineering education. Thirty NITs (which are all Central Institutions), some of the IIITs, along with another 40–50 reputed engineering colleges—around 100 in all—are generally considered to be Tier II institutions. The rest are usually clubbed as Tier III institutions. Majority of the private institutions, with notable exceptions, come under the Tier III category.

9.3 Access and Equity in the Indian Context

India's estimated population in 2013 was 1.22 billion and the median age was 26.7 years (The-World-Factbook; Census of India). While other nations struggle to support their aging population, India's problem is educating over 600 million youth to propel the nation toward its dream. The first big challenge is to increase access to high quality education from a very low base to a reasonable level.

Equity in education means equal opportunities for all. To ensure equity, a nation needs to identify who are at a disadvantage and how these can be removed. A careful analysis of the available data reveals the nature and extent of inequity in the Indian education system. Around 68.8 % of the Indian population lives in rural areas where educational opportunities are very poor. Around 8.2 % of the population, classified as Scheduled Tribes, is excluded from the mainstream mainly because of the remoteness of their habitation (Census of India). Scheduled Castes, who have been denied even basic human rights for centuries, constitute16.2 % of the population. A significant section of the society is classified by the Government of India as belonging to "socially and educationally backward classes," and is given the collective term "Other Backward Classes." Depending on the exact definition of OBC, the estimate of their size varies wildly. Gender bias has been a strong deterrent for Indian women to pursue their studies. Although English is the medium of instruction in higher education, it is not the mother tongue of the vast majority.

Positive discrimination in favor of the disadvantaged has been the traditional strategy across the world to fight inequity. In the Indian context this meant that increasing access to quality education was simply not good enough. Educational opportunities needed to be increased much more in those areas where the disadvantaged lived, in addition to providing other incentives.

9.4 Quantitative Expansion of Indian Engineering Education: The 'Brick and Mortar' Approach

9.4.1 Impact on Access

Since Independence in 1947, engineering education in India has undergone major changes both in scope and scale. From a base of only 50 degree-level engineering institutions in 1950, the country added another 350 institutions during the following 45 years and a whopping 3,098 additional institutions over the next 18 years (1995–2013). The seat capacity at degree level institutions jumped from a mere 2,500 in 1947 to around 50,000 in 1995 and a staggering 17,61,976 by 2013. Figures 9.1 and 9.2 show the growth of engineering degree seats and engineering degree institutions, respectively, during the period 2003–2013 (National

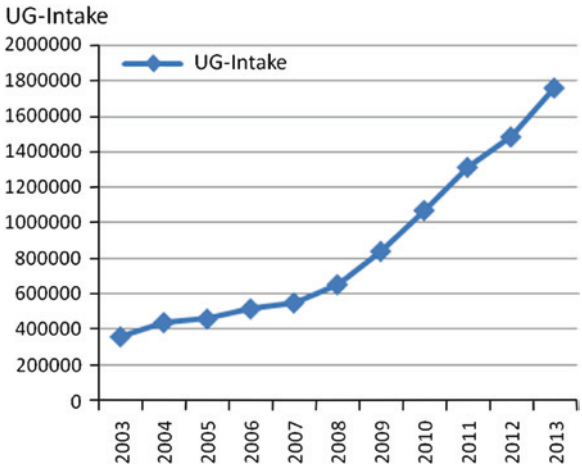

Fig. 9.1 Growth of engineering degree seats in India

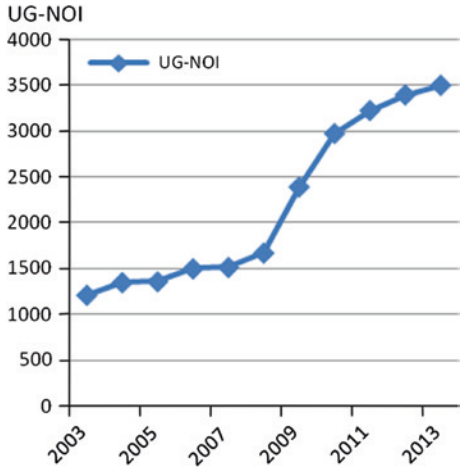

Fig. 9.2 Growth of engineering degree institutions in India

Knowledge Commission 2008; AICTE Annual Reports). Figure 9.3 shows the comparative growth rates of Diploma, UG and PG level engineering education during the period 2007–2013 (AICTE Annual Reports).

Table 9.1 shows a comparison of engineering students per million population in four BRIC and three OECD countries in 2010 (South Asia Human Development Sector International Comparative Study 2013).

The data presented clearly shows that the 'Brick and Mortar' approach to the quantitative expansion of engineering education resulted in spectacular rise both in seat capacity and in the number of institutions in India. The total engineering intake capacity, taking UG and PG together, went up from around 0.9 million in 2007 to around 2.24 million in 2013. However, the data in Table 9.1 shows that this approach did not address the problem adequately. The number of engineering students per million population in India continues to be way below its peers in the OECD and BRIC countries. Access to engineering education continues to be highly unsatisfactory (AICTE Annual Reports 2012).

9.4.2 Impact on Inequity

The data on quantitative expansion, particularly on increase in access via the 'Brick and Mortar' route, hide more than they reveal. How did the increase in access affect the problems of inequity? A simple way to find the answer is to first examine the

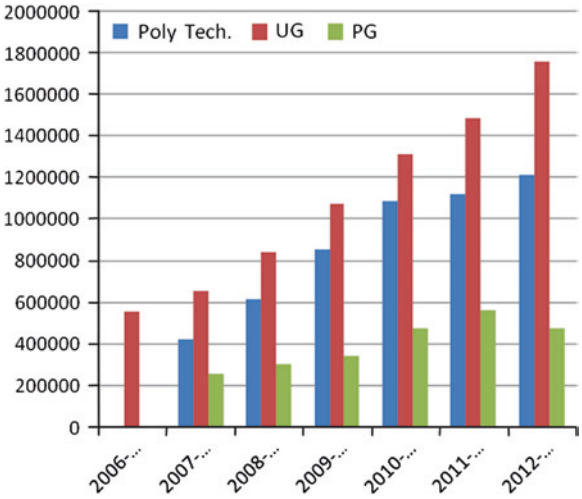

Fig. 9.3 Comparison of growth in Diploma, Degree and PG engineering education in India during 2007–2013

Table 9.1 Number of engineering students per million population

Russia	Japan	China	Brazil	USA	UK	India
11,227	3,791	3,149	2,648	2,570	2,356	1,290

region-wise relative growth in engineering education in recent years. If there are regional imbalances, one needs to see where access is poor and which sections of society are affected the most. For administrative convenience, India is divided into 8 regions by the AICTE. These are: Central, Eastern, Northwestern, Northern, South-central, Southwestern, Southern and Western regions. The Eastern region—second largest in terms of population and third largest in terms of area—includes the seven North Eastern States which have a large percentage of ST population who need positive discrimination to ensure equity. Figure 9.4 shows the region-wise comparative growth pattern in engineering degree seat intake over the period 2005–2012 (AICTE Annual Reports 2005).

Until 2009, the seat capacity in the Northern Region was the lowest (16,766), but by 2012 the capacity jumped by a factor of 5.5 (1,55,056). In the Eastern Region, despite significant expansion after 2008, the intake capacity continued to be much lower compared to the rest of the country. All regions increased capacity noticeably since 2009. This inter-region growth pattern shows that although access to engineering education increased, major regional imbalances persisted, and in many cases, worsened. Access continued to be very uneven across regions. To understand the exact nature of differential access and its implications on the problems of inequity, it is important to examine the micro details of the intra-region access data. Table 9.2 lists the constituent States and UTs of each region, their population, area, seat intake, population per seat for degree level engineering progams for the year 2011–2012 (AICTE Annual Reports; Census of India 2011; Government of India 2001). Table 9.3 lists the data on population per engineering degree seat in three groups for all states and UTs. The entries for the NE States, often called the Seven Sisters are highlighted in gray.

During 2011–2012, for Andhra Pradesh in the South central region, there was one UG engineering seat for every 249 persons, or 4,016 seats per million population, which is nearly three times the national average of 1,290 seats per million

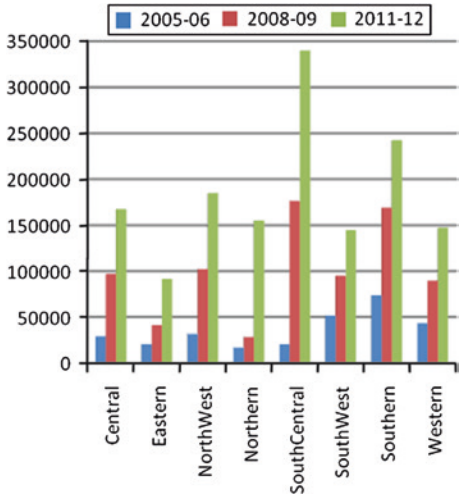

Fig. 9.4 Region-wise growth of degree level engineering seats during 2005–2006, 2008–2009 and 2011–2012

Table 9.2 Region-wise demographic, UG seat intake and population per UG seat data

	State	Population in million	Area (km^2)	Intake (2011–2012) engineering and technology	Population per UG seat
Central	Chhattisgarh	25.54	135.191	24.479	1.043
	Gujarat	60.38	196.024	46.639	1.295
	Madhya Pradesh	72.60	308.245	96.374	753
Eastern	Andaman and Nicobar Islands	0.38	8.249	90	4.222
	Arunachal Pradesh	1.38	83.743	216	6.401
	Assam	31.17	78.438	3.501	8.903
	Jharkhand	32.97	79.714	6.015	5.481
	Manipur	2.72	22.327	155	17.560
	Meghalaya	2.96	22.429	420	7.057
	Mizoram	1.09	21.081	0	
	Orissa	41.95	155.707	45.434	923
	Sikkim	0.61	7.096	558	1.089
	Tripura	3.67	10.486	300	12.237
	West Bengal	91.35	88.752	34.973	2.612
Northwest	Chandigarh	1.05	114	1.551	680
	Delhi	16.75	1.484	7.981	2.099
	Haryana	25.35	44.212	64.298	394
	Himachal Pradesh	6.86	55.673	7.272	943
	Jammu And Kashmir	12.55	222.236	2.471	5.078
	Punjab	27.70	50.362	43.408	638
	Rajasthan	68.62	342.239	58.106	1.181
Northern	Bihar	103.80	94.163	5.209	19.928
	Dadra &Nagar Haveli	0.34	491	0	
	Uttar Pradesh	199.58	240.928	136.417	1.463
	Uttarakhand	10.12	53.483	13.430	753
South-central	Andhra Pradesh	84.66	275.045	340.007	249
Southwest	Karnataka	61.13	191.791	92.376	662
	Kerala	33.39	38.863	52.211	639

(continued)

Table 9.2 (continued)

	State	Population in million	Area (km^2)	Intake (2011–2012) engineering and technology	Population per UG seat
Southern	Puducherry	1.24	479	6103	204
	Tamil Nadu	72.14	130.058	236.417	305
Western	Daman and Diu	0.24	112	0	
	Goa	1.46	3.702	1.200	1.215
	Maharashtra	112.37	307.713	146.116	769

Table 9.3 Population size per engineering degree seat during 2011–2012, arranged in 3 classes

States/UTs	Population per seat	States/UTs	Population per seat		States/UTs	Population per seat
Puducherry	204	Chhattisgarh	1,043		Assam	8,903
Andhra Pradesh	249	Sikkim	1,089		Tripura	12,237
Tamil Nadu	303	Rajasthan	1,181		Manipur	17,560
Haryana	394	Goa	1,215		Bihar	19,928
Punjab	638	Gujarat	1,295		Daman and Diu Pop: 242,911	No seat
Kerala	639	Uttar Pradesh	1,463		Mizoram Pop: 1,091,014	No seat
Karnataka	662	Delhi	299		Nagaland Pop: 1,978,502	No seat
Chandigarh	680	West Bengal	212		Dadra and Nagar Haveli	No seat
Madhya Pradesh	753	Andaman & Nicobar Islands	422		Lakshadweep Pop: 64,429	No seat
Uttarakhand	753	Jammu &Kashmir	578			
Maharashtra	769	Jharkhand	581			
Orissa	923	Arunachal Pradesh	6,401			
Himachal Pradesh	943	Meghalaya	7,053			

population, whereas in Bihar in the Northern region there was one seat for every 19,928 persons, or 50 seats per million population, a mere 4 % of the national average. Bihar also happens to be home to the third largest SC population in India—the most disadvantaged and most downtrodden section of society—needing maximum opportunity to catch up with the rest.

Table 9.4 Evidence of differential access and unequal opportunity from intra- and inter-region data

Total population of the seven NE States = 44,978,194 Total seats = 4,592	Approx 3.7 % of the Indian population Average population per seat = 9795
Population of Orissa = 41,947,358 Total Seats = 45,434;	Approx 3.5 % of Indian population Average population per seat = 923
Population of Dadra & Nagar Haveli: 342,853; Population of Lakshadweep: 64,429; Population of Daman & Diu: 242,911	No Seat No Seat No Seat
Population for Bihar = 103,804,637 Total Seats = 5,209;	Approximately 8.6 % of Indian population Average population per seat = 19,928
National Average = 820 persons per seat	

The intra-region data for the Eastern region shown in Table 9.4 bring out one point forcefully: Inequity remains a problem and needs to be addressed effectively. Mere seat reservations or increasing access through the 'Brick and Mortar' route will not solve this problem. Private institutions were set up mainly with profit motive, in places where high fee paying students lived. They employ inadequately trained teachers for a very low pay in large numbers.

9.4.3 Impact on Quality

What is the quality of engineering education in India? Research output, as indicated by publications, citations, impact factors as well as patents and innovations are important indicators of quality, but the most relevant indicator for India is the opinion of the industry on the employability of fresh graduates. A widely quoted NASSCOM-McKinsey Report published in 2005 stated that "Currently only about 25 % of technical graduates and 10–15 % of general college graduates are suitable for employment in the offshore IT and BPO industries" (Government of India 2001). Although this report related employability specifically to offshore IT and BPO industries, recent studies have confirmed the suspicion that poor quality and thus low employability is a cause for concern across most industries. A World Bank study on "Employer Satisfaction Survey" undertaken in 2009 and published in 2011 confirmed "… a widespread dissatisfaction with the current graduates—64 % of employers hiring fresh engineering graduates are only somewhat satisfied with the quality of the new hires or worse" (Blom and Saeki 2011).

One of the main reasons for deteriorating quality standards is the mushrooming growth in the number of institutions without any effective check on the minimum requirements. According to a recent study, the ratio of private to government engineering institutions in India in 2011 was 93.8 to 6.2, by far

the highest among the seven countries listed in Table 9.1 (Government of India 2001). Andhra Pradesh, with probably the largest number of private engineering colleges and the largest UG intake capacity at 0.34 million, had around 20 % full time faculty members with a Ph.D degree in 2010. The situation is probably worse in other states (Government of India 2001). While China produced 17,000 engineering Ph.D degree holders and USA produced 9,500, the estimated number for India was around 1,000 in 2010 (Government of India 2001). Since the capacity increase in technical education at the master's and doctoral levels were significantly lower than at the undergraduate level, the demand for qualified teachers far outstripped supply, resulting in a drastic loss of quality. Extreme faculty shortage, lack of adequate faculty training programs, outdated curricula, and obsolete teaching learning processes have been cited as major causes responsible for deteriorating quality (National Knowledge Commission 2008; NASSCOM-McKinsey Report 2005).

In summary, one can conclude that the massive increase, mainly in the 'Brick and Mortar' infrastructure, during the last 10 years has

- Increased access significantly but not sufficiently.
- Been quite ineffective in addressing the issues of equity.
- Decreased the quality of education markedly.

9.5 Technology Initiatives in Indian Engineering Education: 1987–2007

Till about the beginning of the twenty-first century when Information Technology had not matured sufficiently, Communication Technology, mainly Broadcast Technology was the first choice everywhere. India was no exception. The 1986 National Policy on Education had recognized this fact and had specifically mentioned:

> Modern communication technologies have the potential to bypass several stages and sequences in the process of development encountered in the earlier decades. Both the constraints of time and distance at once become manageable…modern educational technology must reach out to the most distant areas and the most deprived sections of the beneficiaries simultaneously with… (Blom 2011).

Educational Technology was declared a Thrust Area by the Planning Commission of India in 1986. By 2001, modest ICT infrastructures began to appear in some campuses. IIT Kharagpur commissioned its first high speed campus-wide LAN in 2001. Within weeks, the entire library of video lectures was digitized by the Centre for Educational Technology, IIT Kharagpur, and made available on the campus network as VOD. This was the first ICT-based regular educational service in India. Work had also begun in developing and testing various prototype ICT tools such as Virtual Laboratory, Virtual Classroom, Computer Aided Evaluation Software, and Electronic Test Item Banking.

NPTEL Phase 1 project, started in June 2003, is often considered a path-breaking ICT initiative in the Indian engineering education system (Walsh 2011). Funded by the MHRD, the project was executed with the objective of introducing multimedia and web technology to enhance the learning of basic science and engineering concepts. Phase 1 NPTEL project prepared India to launch the National Mission on Education through ICT in 2009. The lessons learned from these early experiences were used to plan and implement the NMEICT project which used a SWOT study to fine tune national priorities.

9.6 Improving Access, Equity and Quality: Role of ICT

With an ever-increasing demand for high quality education, the ability to extend the reach of good teachers assumes great importance. MOOC is a case in point. Anytime-anywhere instruction tailored to individual needs was a distant dream until recently. Interactive multimedia instruction and virtual reality based instructions can greatly improve the quality of learning. Judicious use of ICT can deliver high quality instruction to all those who need it, at a time and place of their choice. Given the scale of operation, it is clear that India cannot depend only on the expansion of infrastructure through the 'Brick and Mortar' route. Large scale use of ICT is the obvious choice to increase access, improve equity and boost quality.

Taking ground realities into consideration, the Government of India decided to adopt a three-pronged approach to encourage Technology Enhanced Learning at the national level. The main thrust areas identified are:

1. High quality e-content creation in the OER mode using the best available faculty members in the country. The range and scope of e-content include video courses, web courses, virtual laboratories, simulation tools, spoken tutorials, and a variety of others, covering UG and PG level technical education. Declaring all newly created e-content as free Open Educational Resource is a deliberate decision to allow their use by everyone.
2. Massive increase in highly subsidized network connectivity to all universities and all technical institutions in the country.
3. Development of a versatile and easily affordable digital access device at the earliest.

Large-scale teacher training using ICT tools and developing suitable pedagogical methods for different classes, calibers and research in e-learning are the other two priority areas. It is assumed that in not too distant a future, internet and mobile penetration in India would rise significantly. The combined effect of increased connectivity, affordable access devices and free high quality e-content is expected to go a long way toward addressing the issues of access, equity, and quality. In order to implement these policies the MHRD decided to launch a National Mission on Education through ICT in 2009 (Gautam et al. 2010). Selected examples of implementation of the NMEICT project are highlighted below.

9.7 Selected Examples of NMEICT Initiatives: 2009–2012

By 2005, the Government of India had already created a special division of Technology Enhanced Learning in the Higher Education Department. Long into the planning stage, the National Mission on Education through ICT was finally launched by the MHRD in February 2009. The primary focus of the NMEICT was on, but not limited to, higher technical education. The sanctioned budget for the 4-year period (2008–2012) was INR 46.12 billion. All software, e-content, and educational products developed under the NMEICT project were to be available as free-of-cost Open Educational Resource under Creative Commons. The MHRD also started a one-stop educational portal—"Sakshat"—allowing free access to all NMEICT sponsored developments to everyone. Details of all projects under the NMEICT are available in this portal (National Policy on Education (NPE) 1986). All NMEICT projects have their own website with links to Sakshat. Out of the many important projects, only a few are briefly reviewed below. Details of other large projects initiated toward the end of 2012 or early 2013 (MOOC, DTH) are available in the Sakshat website.

9.7.1 Providing Connectivity to Academic Institutions

NMEICT accorded top priority in ensuring connectivity to every educational institution in India by 2012. The Mission Document made it clear that "the bandwidth provisioning would have to be considered as an educational infrastructure, and bandwidth for educational purposes would have to be made free from the user's point of view." By the end of 2012, over 419 universities and 20,000 colleges were connected. Each university has been provided with 1 Gbps connectivity via NKN and a LAN of about 20 Nodes under the NMEICT. Actual bandwidth available will depend on the use. Each college has been provided with 20 × 512 Kbps connectivity which may be clubbed together if needed. Barring some exceptions, the project target was met well in time.

9.7.2 Low Cost Access Device: Aakash

Development of a low-cost, feature-rich access device was considered one of the basic requirements for the success of the NMEICT project. Named Aakash, it is probably the world's cheapest Data Tablet in its class. The MHRD aims to acquire initially about five million Aakash tablets at INR 2,276 each, in a phased manner. Eventually, this number may be higher to achieve economy of scale. The Government of India will subsidize 50 % of the cost for students. Aakash is a 7Tablet-cum-Computing Device based on Android. Since it is Wi-Fi enabled and the advanced versions have provision of a SIM card, Aakash can receive and

display all content developed by the NMEICT. It has a large in-built selection of free Educational Apps developed by students. IIT Bombay is the coordinating institution for this project.

9.7.3 NPTEL: Phase 2

NPTEL—Phase 2 is a continuation of the earlier project with a significantly enhanced scope. The main objective is to develop high quality e-content in the form of video and web courses which can be used as teaching resources by faculty and learning resources by the students and the public at large. Around 1,000 one-semester duration (40 × 1 h) UG and PG level courses covering the curricula of most engineering disciplines are being developed. Approximately a third of these are related to physical sciences, mathematics, management and humanities, and social sciences. The distribution network includes several distributed video servers, YouTube, and hard disks containing all courses to any institution who may wish to use its own campus servers and LAN. NPTEL is by far the largest high-quality OER for UG and PG level engineering education in the world. IIT Madras is the coordinating institution for NPTEL (National Mission on Education through Information and Communication Technology).

9.7.4 Virtual Labs

Many new engineering colleges in India have very poor laboratory facilities. In many institutions, faculty members are not even sufficiently qualified to conduct laboratory classes. The Virtual Laboratory Project, undertaken by 12 leading institutions, is expected to help bridge this gap. By the end of 2012, the project completed 108 laboratories covering nine engineering and science disciplines, exceeding the original target of 90 laboratories. Some of these laboratories are modeling-and simulation-based allowing significant scaling up, a few are measurement-based allowing remote access to expensive equipment located in a handful of institutions, and the third category is classed as remote triggered. All V-Labs are accessible through a single portal. IIT Delhi is the coordinating institution for V-Labs (Sakshat).

9.7.5 Pedagogy

There is a desperate need to modernize the teaching-learning process in India. Leaving out the top tier institutions, curricula of most engineering programs bear little relationship to the requirements of the industry (Blom and Saeki 2011). Most

faculty members are unaware of the basic concepts of outcome-based learning or pedagogy. Average class sizes have increased to near unmanageable proportions. To address these problems, an ambitious project entitled "Developing suitable pedagogical methods for different classes, calibers and research in e-learning," 'Pedagogy Project' in short, was initiated in 2009. The project aims to train a minimum of 3,000 engineering faculty members in the basics of pedagogy and outcome-based learning through a mixture of hands-on workshops and web-based tools. It has developed a web tool to allow collaborative development, review and monitoring of outcome-based curricula by experts located in different geographical locations.

Complete curricula for a selected list of 200 one-semester long theory courses in engineering will be available as OER on the project website. The curricula will include Course Overview, Course Objectives, Module Overview, Module Objectives, Unit Objectives, Self Assessment test items with solutions matched to objectives, Objective-wise Learning Resource reference lists and a short summary of each unit. As these are all Open Educational Resources, it is expected that continuous improvement will take place through wide participation by all stakeholders. It is also expected that faculty members would encourage students to learn in small collaborative groups, monitoring their progress continuously. Such exhaustive curriculum documents should add transparency to the teaching-learning process and benefit everyone. True, open, and collaborative learning and mentoring are the important outcomes of this project.

The main phase of the project started in April 2013. IIT Kharagpur is the coordinating institution (National Programme on Technology Enhanced Learning).

9.7.6 A-View

Amrita Virtual Interactive E-Learning World, popularly known as A-View, is a sophisticated Virtual Classroom software developed by Amrita University in association with IIT Bombay as part of the NMEICT project. As with all NMEICT projects, A-View is available free to all educational institutions in India. Several hundred colleges are using this tool to share expertise. A-View supports several other important teacher training projects (Virtual Labs).

9.7.7 T10KT

Talk to 10,000 Teachers is an ambitious ICT-supported teacher training program initiated by the MHRD under the NMEICT project in 2009. In the pilot phase, completed in March 2013, IIT Bombay experimented with the concept of training a large number of engineering teachers from across the country synchronously in Distance Mode using the A-View e-learning platform. After successful trials involving around 1,000 teachers at a time, it was decided to scale up the project

to train 10,000 teachers at a time. The enlarged project called T10KT is now being jointly conducted by IIT Bombay and IIT Kharagpur. The target is to train 1,50,000 teachers in a combination of synchronous and asynchronous modes in a period of 3 years.

9.7.8 Fossee

IIT Bombay has taken up the responsibility for a project to develop Free and Open Source Software for Engineering and Science Education—named FOSSEE—supported by the NMEICT. The FOSSEE project has successfully developed a software tool for Computational Fluid Dynamics (CFD) and also Oscad, which is an open source EDA tool. The team has also been vigorously promoting the use of Python and Scilab. All these tools are available in the Aakash Tablet.

9.7.9 ERP

The primary objective of this project is to develop an open source MIS tool to allow efficient management of educational institutions and provide easy access to information for authorized users. This multi-institution collaborative project would also help deployment and management of ERP services in all educational institutions in India. The ERP system has been named Brihaspati and includes Library Management System, Learning Management Systems and Student Behavior Tracking, in addition to the other usual features. IIT Kanpur is the coordinating institution.

9.8 Examples of Other Recent ICT Initiatives

Realizing the opportunities, several large companies have recently entered the field and started providing e-learning infrastructure and services. Hughes Net and Reliance World tied up with some of the IITs, IIMs and XLRI (a renowned Management Institution) for providing executive MBA programs through their video classrooms located in different cities. ORACLE has started marketing their ERP system specifically tailored for management of educational organizations. A large number of startup companies are developing a variety of e-learning software, simulation and animation tools, and computer aided assessment and evaluation software. Their growth is slow, however, as most institutions are reluctant to make any investment for quality improvement. Cost reduction is their primary concern.

The E-learning division of DeitY has been supporting several R&D projects being carried out at different C-DAC and other government R&D organizations.

Some examples are: Real time Video Compression and Decompression Techniques, Developing Authoring Tools in Indian Languages, Developing Content Independent of Platform and Environment, and Quality Assurance in E-learning.

9.9 Current Status

Over the last 25 years, India's attempts to address its imperatives of access, equity, and quality in engineering education have been a blend of the traditional approach of expanding physical infrastructure, enacting and implementing appropriate enabling legislations, and encouraging technology intervention in education. In the initial years, when the sector had just opened up, the quantitative expansion was led by the private sector. The government did not have adequate resources to lead the growth. With time, this growth accelerated, peaking around 2009 and then tapering off by 2013. Quality had plummeted, as the dominant motive of the private sector was quick profit and not quality. Use of technology in engineering education, on the other hand, has been primarily led by the government, growing steadily until 2009 and then rapidly accelerating, NMEICT being the trigger. Technology made slow inroads into education for the simple reason that the country neither had the appropriate technology nor did it have adequate experience in Educational Technology. The Indian government made conscious efforts to overcome these shortcomings as a preparation for a major ICT intervention at the earliest. A SWOT analysis was carried out around 2007. The analysis revealed that the few strengths that India had included the availability of a few thousand expert faculty members in the top rung institutions, good expertise in IT-related fields and Edusat. Weaknesses were too many, the chief being the extreme shortage of qualified faculty members in the rest of the institutions. NMEICT, the biggest Indian ICT initiative in education, was launched. The targets set for most of the NMEICT projects have either been already met or will be met soon. Connectivity is still a bottleneck, but less serious than in the past. NPTEL courses, V-labs and other e-content are increasingly becoming popular. Hopefully, Aakash will soon be available in large numbers at the envisaged price. Increasing awareness and integration into the teaching-learning practice are the next steps. It still is difficult to quantify the impact of the ongoing ICT intervention in addressing the issues of access, equity, and quality. Impact assessment studies need to follow.

9.10 Future Directions

What lies ahead? Which direction will future ICT take and how would it affect education? Could ICT help extend engineering education beyond the cognitive domain? What can possibly be the future role of faculty? Predictions published

in the New Media Consortium Horizon Report: 2013, K-12 Edition, regarding the top ten emerging technologies with possible time frames of adoption in learning are reproduced below (Developing suitable methods).

Emerging technologies	Predicted adoption time
Cloud computing, Mobile learning,	
Tablet computing, MOOCs	1 year or less
Open content, Learning analytics,	
Games and gamification	2–3 years
3D printing, Virtual and remote laboratories,	
Wearable technologies	4–5 years

As already elaborated, Tablet Computing and Virtual and Remote Laboratories are already on India's priorities. Initial experiments with MOOC have already started. More are planned by different IITs in the near future. A great deal of NPTEL e-content is already available as part of mobile learning. All new e-content created under the NMEICT are OER—free for all. Open Learning is the core principle of the Pedagogy Project. Research on the use of Learning Analytics in the Pedagogy Project is going to be initiated soon.

It is possible to broadly classify emerging technologies as Adaptive or Non-adaptive. Several highly advanced adaptive technologies for training and education are currently in the research and development stage around the world (A-View). Most of these are fundamentally Intelligent Tutoring Systems with advanced student and pedagogic modeling. The Center for Educational Technology, IIT Kharagpur, has just initiated research in this area. Intelligent use of Learning Analytics makes these technologies extremely effective. The highly acclaimed Cognitive Tutoring Technology developed at an enormous cost by CMU is a good example of this category (Walsh 2011; Toward cognitive tutoring 2013). For India, cost is likely to be the major limiting factor for this category of technologies.

With large scale availability of high-quality learning resources, rising mobile and internet penetration, availability of cheap access-cum-computing devices, rapidly falling costs of electronic storage and an increasing importance being attached to "learning to learn" as a highly desirable skill, the emphasis is clearly shifting from teacher-centric to learner-centric education. Teachers will no longer need to focus on delivering content in the classroom. Teachers will need to create good quality e-content, if this is not already available. The responsibility of learning will gradually shift to the learners. Until fully adaptive learning technologies become the norm rather than the exception, which is only a long-term possibility, facilitating learning is expected to be the primary function of most teachers. The emphasis placed by the NMEICT on creating e-content, scaling up connectivity many folds and ensuring availability of cheap access devices suggests that blended learning is going to replace traditional classroom teaching in not too distant a future. The NMEICT sponsored "Pedagogy Project" strongly advocates outcome-based open

learning, blended learning and collaborative mentoring. Elaborating on the ICT policy in Education in their website, the AICTE declared: "Several projects are in the completion stage and are expected to change the way teaching and learning is done in India. The case in point is the project: Developing suitable pedagogical methods for various classes, intellectual calibers and research in e-learning anchored by IIT Kharagpur." (Durlach and Lesgold 2012)

9.11 Conclusions

The imperatives of access, equity and quality in education are top policy priorities for every nation. No country, particularly countries with very large populations and sizes, can afford to address these issues only through physical expansion of infrastructure and affirmative legislations. This approach is inefficient, uneconomical and slow to execute. Over-reliance on the private sector has not been a happy experience for India. Effective use of ICT in education can go a long way toward enhancing access, equity, and quality. Integrating proven ICT tools in education is as important as initiating research in developing and using advanced ICT tools as a preparation for the future. In the long term, there is no alternative to capacity building for those who lack it. Acceptance and integration of ICT in the teaching–learning process requires long and sustained efforts. Teachers are not going to be an extinct species because of the intervention of ICT in education. On the contrary, they will need to take up far more challenging roles. They will need to plan, innovate and facilitate learning. For India, the struggle to become the largest knowledge society has just begun.

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Chapter 10
Towards Modelling Teachers' ICT Competence Profile in Europe

Panagiotis Zervas, Konstantinos Chatzistavrianos and Demetrios G. Sampson

Abstract In all European countries many activities are undertaken to promote the use of ICT in school education. Nevertheless, the full potential of ICT is not being exploited. One of the main reasons for this is the lack of teachers' familiarization with the use of ICT. Therefore, there are increased efforts worldwide for the design of teachers' professional development programmes that aim to enhance teachers' competences for the use of ICT in school education. However, these programmes are mainly designed to address ICT competences that are based on different teachers' ICT competence frameworks that have been recently developed. Although these competence frameworks aim to tackle the same problem, the diversity in their approaches leads to heterogeneous competence descriptions that cannot be formally described and represented in a unified manner among different European Union Member States. To this end, it is important to model teachers' ICT competence profile at a European Level in a common and systematic way. This can facilitate the design of teachers' professional development programmes, which will address universal competences descriptions. Within this context, in this chapter, we focus on (a) modelling teachers' ICT competence profile in Europe by considering existing teachers' ICT competence frameworks and selecting the most appropriate and (b) describing, in a machine readable way, the proposed teachers'

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R. Huang et al. (eds.), *ICT in Education in Global Context*,
Lecture Notes in Educational Technology, DOI: 10.1007/978-3-662-43927-2_10

ICT competence profile by exploiting existing specifications for competences description.

Keywords Teacher competence · Competences frameworks · Competence modelling · Competences specifications

10.1 Introduction

In all European Union Member States, national policies for ICT in school education exist, and many activities are undertaken to promote the use of ICT in school education (Eurydice 2011). Nevertheless, while the technical infrastructure to promote ICT use for learning is widely available nowadays, the full potential of ICT is not being exploited in school education. One of the reported reasons for this is the lack of teachers' familiarization with the use of ICT (Sang et al. 2010). Therefore, there are increased efforts worldwide for the design of teachers' professional development programmes that will enhance teachers' competences for the use of ICT in school education.

However, these programmes are mainly designed to address ICT competences that are based on different teachers' ICT competence frameworks that have been recently developed (EIfEL 2008; eTQF 2010; UNESCO 2011; Hooker et al. 2011; French Ministry of Higher Education and Research 2012). These competence frameworks aim to provide a basic set of competences that allows teachers to integrate ICT into their teaching, to advance their students' learning and to improve other professional duties (Vandam et al. 2010). Despite the fact that all these competence frameworks aim to tackle the same problem, the diversity in their approaches leads to heterogeneous ICT competences descriptions that cannot be formally described and represented in a unified manner among different European countries.

To this end, it is important to model teachers' ICT competence profile at a European Level in a common and systematic way. This approach can facilitate the design of teachers' professional development programmes that will address universal ICT competences descriptions. Moreover, this approach could enable the modelling of teachers' ICT competence profile with existing specifications for competences description such as the IMS Reusable Definition of Competency or Educational Objective (RDCEO) Specification (IMS RDCEO 2002), the HR-XML Specification (HR-XML Consortium 2011) and the Integrating Learning Outcomes and Competences (InLOC) Specification (Hoel and Grant 2013) and facilitate the interoperability among different systems, which are used for teachers' continuous professional development, assessment and recognition of competences.

Within this context, in this chapter we focus on (a) modelling teachers' ICT competence profile in Europe by considering existing teachers' ICT competence frameworks and selecting the most appropriate and (b) describing, in a machine readable way, the proposed teachers' ICT competence profile by exploiting existing specifications for competences description.

10.2 Background: Competence and Competence Frameworks

Competences have been proved to be an important tool in human resource management, life-long learning and performance management (Tripathi and Ranjan 2013; Rothwell 2012; Miao et al. 2009). More precisely, in human resource management, competences can be used as part of the criteria to select the most appropriate available professional (Rothwell 2012). Competence-based selection is driven by the assumption that achieving a closer match between the requirements of the task in hand and an individual's competences will result in higher job performance and satisfaction. In life-long learning, competences can be used as the drivers for the design of appropriate just-in-time and on-demand continuing professional development interventions towards eliminating the gap identified between competences needed and those available (Miao et al. 2009). Finally, in performance management, competences can be combined with data obtained from the analysis of educational tasks and processes in certain teaching contexts to recommend reflective re-design of these educational activities (Tripathi and Ranjan 2013).

A competence is defined as: *a set of knowledge, skills and attitudes that an individual possess or needs to acquire, in order to perform an activity within a specific context. Performance may range from the basic level of proficiency to the highest levels of excellence* (Sampson and Fytros 2008). A key observation from this definition is that the concept of competence relates to the following dimensions:

- *The person's knowledge, skills and attitudes*: Knowledge can be defined as awareness, information or understanding about facts, rules, principles, guidelines, concepts, theories or processes needed to successfully perform a task (Becerra-Fenandez et al. 2004). A skill is the capacity to perform physical or mental tasks with a specified outcome (Sanghi 2007). Finally, attitudes are considered as complex mental states involving beliefs and feelings and values and dispositions to act in certain ways (Gagne et al. 2005).
- *The competence proficiency level of a person with respect to a specific context*: Proficiency levels are used to classify competences according to the performance of the person when demonstrating the competence and with respect to a specific context. Different scales (qualitative and quantitative) may be used to represent proficiency levels according to the context in which the competence is applied.
- *The context in which the competence is applied*: Context can be defined as: "any information that can be used to characterize the situation of an entity. An entity is a person, place or object that is considered relevant to the interaction *between a user and an application, including the user and applications themselves*" (Dey and Abowd 2000). In particular, for the field of competences, the concept of context can be considered as a specific occupation or a set of topics within a specific domain.

In order to define the required competences for a specific job or task, competence frameworks are designed and developed worldwide (Young and Chapman 2010;

Ennis 2008). A competence framework is a model that lists the competences of individuals, which are required for 'excellent' performance within an organization or sector (Marrelli et al. 2005; Rodriguez et al. 2002). Each of these competences is defined in a way that makes them relevant to the organization or sector, using language that is clear enough to ensure that everyone has a common understanding of what 'excellent' job behaviour looks like within the specific context. This common understanding then becomes the benchmark against which the performance of an individual can be assessed (Chapman and O' Neill 2010; Masduki et al. 2010; Draganidis and Mentzas 2006). A critical aspect of all competence frameworks is the degree of detail. If a framework is too general, then its direction can appear vague. If, on the other hand, it is too detailed, then its focus can become diffused and it may lose credibility (Hartley et al. 2010).

Within the literature there are several methods for developing competence frameworks. Boulter et al. (1998) have suggested a six-step process, which starts with the definition of the necessary optimal performance criteria for a specific job or task. Next, the process includes consultation and interviews with senior members inside an organization and data collection. Afterwards, an initial competence framework is developed based on the observed data, which is validated and reviewed by the previous contacted senior members of the organization. The final step of this process includes the implementation of the resulted framework within the organization. A similar method has been introduced by Lucia and Lepsinger (1999), who have proposed a detailed twelve-step process divided into three main phases, namely: (a) preliminary work, where the goals for developing the competence framework are defined, as well as the proficiency levels of the competences of the framework, (b) consultation with staff members, data collection and initial framework construction and (c) validation of the framework and refinements based on feedback received by external experts. Marrelli et al. (2005) propose to include additional steps for training staff members of the organization that are involved in the step of consultation with the team developing the competence framework. Finally, a commonly used method for developing competence frameworks has been proposed by Draganidis and Mentzas (2006). It includes nine steps. These steps are aligned with the steps proposed by previous works, but they propose additional steps for the incorporation of the validation process within the actual implementation stage, where staff performance is measured.

After discussing different methods for competence frameworks' development, in the next section, we focus on a specific type of frameworks, namely ICT competence frameworks for teachers.

10.3 Review of Teachers' ICT Competence Frameworks

In this section, we provide an overview of a list of five (5) well-known, existing teachers' ICT competence frameworks. These were identified from a thorough review of the relevant literature. For each competence framework, we analyze the following

elements: (a) general information about the competence framework such as the creator and the year it was published, (b) the competences' categories, (c) the number of competences per competence category, (d) the competence proficiency levels and (e) the number of sub-competences per competence and per proficiency level.

10.3.1 Description of Existing Teachers' ICT Competence Frameworks

The eLearning Competency Framework for Teachers and Trainers (EIfEL 2008) has been developed by the European Institute for e-Learning. It includes six categories of competences and six proficiency levels for each of these categories. Each proficiency level includes one main competence, which is further divided in sub-competences. Table 10.1 presents the eLearning Competency Framework for Teachers and Trainers competences' categories, as well as the sub-competences per proficiency level.

As we can notice from Table 10.1, the total number of sub-competences that a teacher should possess to attain each level varies from 16 sub-competences (at level 1) to 2 sub-competences (at level 6). The total number of sub-competences that the competence framework defines is 47.

Table 10.1 eLearning competency framework for teachers and trainers

Categories	Proficiency level 1	Proficiency level 2	Proficiency level 3	Proficiency level 4	Proficiency level 5	Proficiency level 6
Preparing a learning event	2	2	3	4	3	–
Running a learning event	4	2	–	–	–	–
Supporting learners	4	2	4	3	2	2
Assessing learner progress	2	4	–	–	–	–
Promoting accessibility for learners	2	–	–	–	–	–
Evaluating learning programmes	2	–	–	–	–	–
Total sub-competences	16	10	7	7	5	2

The eTQF Teacher ICT Competency Framework (eTQF 2010) has been developed in the context of an EU-funded project, referred to as "eTQF: Teachers Competency and Qualifications Framework in the use of ICT's in education'. It includes four categories of competences and four proficiency levels. Each proficiency level includes one or more competences. It should be noted that the competence framework does not divide the competences into further sub-competences. Table 10.2 presents the eTQF Teacher ICT Competency Framework competences' categories, as well as the competences per proficiency level.

As Table 10.2 depicts, the total number of competences that a teacher should possess to attain each level is the same for every level, namely 13 competences. The total number of competences that the competence framework defines is 52.

The UNESCO ICT Competency Framework for Teachers (UNESCO 2011) has been developed by United Nations Educational, Scientific and Cultural Organization (UNESCO). It comprises six categories of competences and three proficiency levels. Each proficiency level includes one main competence, which is divided into two or more sub-competences. Table 10.3 presents the competences' categories of the UNESCO ICT Competency Framework for Teachers (UNESCO ICT-CFT), as well as the sub-competences per proficiency level.

Table 10.2 eTQF teacher ICT competency framework

Categories	Proficiency level 1	Proficiency level 2	Proficiency level 3	Proficiency level 4
ICT	6	6	6	6
Pedagogy	3	3	3	3
Curriculum and assessment	3	3	3	3
Teacher professional development	1	1	1	1
Total competences	13	13	13	13

Table 10.3 UNESCO ICT competency framework for teachers (UNESCO ICT-CFT)

Categories	Proficiency level 1	Proficiency level 2	Proficiency level 3
Understanding ICT in education	1	1	1
Curriculum and assessment	1	2	5
Pedagogy	3	6	5
ICT	11	7	1
School organization and administration	3	2	2
Teacher professional development	3	3	4
Total sub-competences	22	21	18

As we can notice from Table 10.3, the total number of sub-competences that a teacher should possess in each level varies from 22 sub-competences (at level 1) to 17 sub-competences (at level 3). The total number of sub-competences that the competence framework defines is 61.

The Tanzanian ICT Competency Framework for Teachers (Hooker et al. 2011) has been developed by the Tanzanian Ministry of Education and Vocational Training and it is based on the UNESCO ICT-CFT with some adaptations to address local educational needs. It includes six categories of competences and four proficiency levels. Each proficiency level includes a variant number of competences. It should be noted that the competence framework does not divide the competences to further sub-competences. Table 10.4 presents the Tanzanian ICT Competency Framework for Teachers competences' categories, as well as the competences per proficiency level.

As we can notice from Table 10.4, the number of required competences for attaining each level is the same, namely 27 competences. The total number of competences that the competence framework defines is 108.

The French Competency Framework—Computing and Internet Certificate for Teachers (French Ministry of Higher Education and Research 2012) has been developed by the French Ministry of Higher Education and Research. It includes two categories of competences and five proficiency levels. Each proficiency level includes one or more competences. It should be noted that the competence framework does not divide the competences to further sub-competences. Table 10.5 presents the French Competency Framework—Computing and Internet Certificate for Teachers competences' categories, as well as the competences per proficiency level.

As we can notice from Table 10.3, the total number of competences necessary for attaining each level varies from seven competences (at level 1) to three competences (at level 5). The total number of competences that the competence framework defines is 28.

Table 10.4 Tanzanian ICT competency framework for teachers

Categories	Proficiency level 1	Proficiency level 2	Proficiency level 3	Proficiency level 4
Policy and vision	2	2	2	2
Curriculum and assessment	6	6	6	6
Pedagogy	4	4	4	4
ICT	8	8	8	8
School organization and administration	4	4	4	4
Teacher professional development	3	3	3	3
Total competences	27	27	27	27

Table 10.5 French competency framework—computing and Internet certificate for teachers

Categories	Proficiency level 1	Proficiency level 2	Proficiency level 3	Proficiency level 4	Proficiency level 5
Working as a teacher	3	3	3	2	1
Teach with ICT	4	4	4	2	2
Total competences	7	7	7	4	3

Table 10.6 Overview of existing teachers' ICT competence frameworks

Competence framework	Year	Region coverage	Categories	Proficiency levels	Competences	Sub-competences
eLearning competency framework for teachers and trainers	2008	Regional (Europe)	6	6	17	47
eTQF teacher ICT competency framework	2010	Regional (Europe)	4	4	52	–
UNESCO ICT competency framework for teachers	2011	International	6	3	18	61
Tanzanian ICT competency framework for teachers	2011	Local (Tanzania)	6	4	108	–
French competency framework—computing and internet certificate for teachers	2012	Local (France)	2	5	28	–

10.3.2 Comparative Analysis and Outcomes

Table 10.6 summarizes the ICT competence frameworks that were analyzed in Sect. 10.3.1. More specifically, Table 10.6 provides details about: (a) the year when the competence framework was published, (b) the regional coverage of the competence framework, (c) the number of competence categories, (d) the number of proficiency levels, (e) the total number of competences and (f) the total number of sub-competences.

As it can be depicted from Table 10.6, only two out of five competence frameworks analyze their competences into sub-competences. This is an important feature

for competence frameworks to incorporate, because sub-competences can be considered as a qualitative scale for the attainment of a specific competence, and they could significantly enhance the level of granularity of the competences measurement process. In particular, the UNESCO ICT-CFT is the most comprehensive competence framework in this regard, since it incorporates the highest number of sub-competences. Moreover, UNESCO ICT-CFT has a broader scope in terms of region coverage and it could be adapted to accommodate local educational needs, as it is the case for the Tanzanian ICT Competency Framework for Teachers.

Finally, a thorough content analysis was performed and a mapping of all competences and sub-competences described in all examined teachers' ICT competence frameworks against the UNESCO ICT-CFT was conducted. This mapping revealed that the latter fully and adequately incorporates the competence-related information provided by all the other competence frameworks.

As a result of the abovementioned reasons, the UNESCO ICT-CFT can be selected for modelling teachers' ICT competence profile at a European level.

10.4 Review of International Specifications for Competences Description

Competences can be formally described and inter-exchanged among different systems by using existing specifications for competences description. In this section, we provide an overview of existing specifications for competences' description, and we perform a comparative analysis of them, so as to select the most appropriate specification for describing in a machine readable way the proposed teachers' ICT competence profile.

10.4.1 Description of Existing International Specifications for Competences Description

The IMS Reusable Definition of Competency or Educational Objective (RDCEO) Specification has been developed by IMS Global Learning Consortium (IMS GLC). The main aim of this specification is to provide a standard notation language for describing, referencing and exchanging definitions of competences and educational objectives (IMS RDCEO 2002). IMS RDCEO includes the following main elements: (a) *identifier,* which is a globally unique label assigned to identify or classify the competence, (b) *title*, which is a short name for the competence, (c) *description,* which is a narrative description of the competence, (d) *definition,* which is a structured description that provides a more complete definition of the competence (such as the competence proficiency level), (e) *taxonomy,* which is the taxonomy or the competence framework the competence belongs to and (f) *personal information,* which is information about the individual that possesses the competence described.

The HR-XML Specification (HR-XML Consortium 2011) has been developed by the HR-XML consortium, so as to mainly address the needs of the human resource management field. For this reason, HR-XML has been designed to be able to record evidence used to substantiate a competence with ratings and weights, which can be used to rank, compare and evaluate the sufficiency or desirability of a competence. HR-XML provides similar elements to the IMS RDCEO, but it further provides elements for: (a) *measurable evidences* and (b) *measurable weights.* The former is information used to prove the existence, sufficiency or level of a competence. Evidences might include test results, certificates, licenses or a record of direct observation, such as a report given by a former supervisor or other employment reference. The latter includes information on the relative importance of the competence or the sufficiency required or other type of dimension.

The Integrating Learning Outcomes and Competences (InLOC) Specification (Hoel and Grant 2013) is the main outcome of the InLOC project of the CEN Workshop on Learning Technologies. The main aim of this specification is to define and structure learning outcomes and competences, which are called 'LOCs'. InLOC provides the following main elements: (a) *LOC structure,* which is used to define the competence framework that the competence belongs to, (b) *LOC definition*, which is used to define the competence of an individual and (c) *LOC association,* which is used to define the relations between competence categories, competences and sub-competences, as well as the competence proficiency levels.

10.4.2 Comparative Analysis and Outcomes

Table 10.7 presents a comparative analysis of the specifications for competences description that were analyzed in Sect. 10.4.1. The scope of this comparison is to identify whether the information model of the existing specifications for competences description can adequately describe the elements of a competence framework, as identified in Sect. 10.3.

As we can notice from Table 10.7, IMS RDCEO cannot support the description of competence categories, as well as the description of relations between competences and sub-competences. The latter is partially supported by HR-XML. This means that although sub-competences can be defined with the HR-XML information model, they cannot be explicitly related to competences. This drawback renders

Table 10.7 Comparison of existing specifications for competences description

Competence framework elements	IMS RDCEO	HR-XML	InLOC
Framework attributes	✓	✓	✓
Competence category	–	✓	✓
Competence attributes	✓	✓	✓
Associated sub-competences	–	Partially	✓
Proficiency levels	✓	✓	✓

them not machine-understandable and limits the scope of interoperability among different systems. On the other hand, it seems that InLOC can support the description of all elements of a competence framework. As a result, InLOC can be selected for the machine-readable representation of the proposed teachers' ICT competence profile, which will be based on UNESCO ICT-CFT, as discussed in Sect. 10.3.2.

10.5 Modelling Teachers' ICT Competence Profile

This section presents a more detailed analysis of the UNESCO ICT-CFT, which was proposed in Sect. 10.3.2 for modelling the teachers' ICT competence profile in European level. More precisely, the UNESCO ICT-CFT is organized around three proficiency levels, namely (a) *technology literacy*, (b) *knowledge deepening* and (c) *knowledge creation* (UNESCO 2011). The first level describes competences necessary for teachers to be able to help students to use ICT in order to learn more efficiently. The second level promotes competences to enable teachers to help students to acquire in-depth knowledge of their school subjects and apply it to complex real-world problems. Finally, the third level prepares teachers for helping students, citizens and the workforce they become, to create the new knowledge required for more harmonious, fulfilling and prosperous societies.

Moreover, the UNESCO ICT-CFT includes six categories of competences, as follows (UNESCO 2011): (a) *understanding ICT in education*, which is related to (sub)-competences about policies and how classroom practices correspond to and support policy, (b) *curriculum and assessment*, which is related to (sub)-competences about the curriculum standards and how teachers can integrate the use of ICT into the curriculum, (c) *pedagogy*, which is related to (sub)-competences about where, with whom, when and how to use ICT for classroom learning activities, (d) *ICT*, which is related to (sub)-competences about the use of hardware and software tools, (e) *school organization and administration*, which is related to (sub)-competences about the use of ICT with the whole class, small groups and individual activities and, finally, (f) *teacher professional development*, which is related to (sub)-competences about the use of web resources, so as teachers to support their own professional development.

Each competence category includes one main competence and each main competence is further divided into sub-competences. Table 10.8 presents the competence categories and the different competences per proficiency level.

Additionally, we provide a structural representation of the UNESCO ICT-CFT, which aims to illustrate the hierarchy and the interrelation between the different elements of the framework. Figure 10.1 depicts the overall structure of the UNESCO ICT-CFT.

As we can notice from Fig. 10.1, the competence framework consists of three hierarchical elements, namely the competence category, the competence and the sub-competence. Next, we present how these hierarchical elements and their attributes can be represented in a machine readable format by using the InLOC specification.

Table 10.8 UNESCO ICT-CFT main competences per proficiency level (UNESCO, 2011)

	Technology literacy (Level 1)	Knowledge deepening (Level 2)	Knowledge creation (Level 3)
Understanding ICT in Education	Policy awareness	Policy understanding	Policy innovation
Curriculum and assessment	Basic knowledge	Knowledge application	Knowledge society skills
Pedagogy	Integrate technology	Complex problem solving	Self management
ICT	Basic tools	Complex tools	Pervasive tools
School organization and administration	Standard classroom	Collaborative groups	Learning organizations
Teacher professional development	Digital literacy	Manage and guide	Teacher as model learner

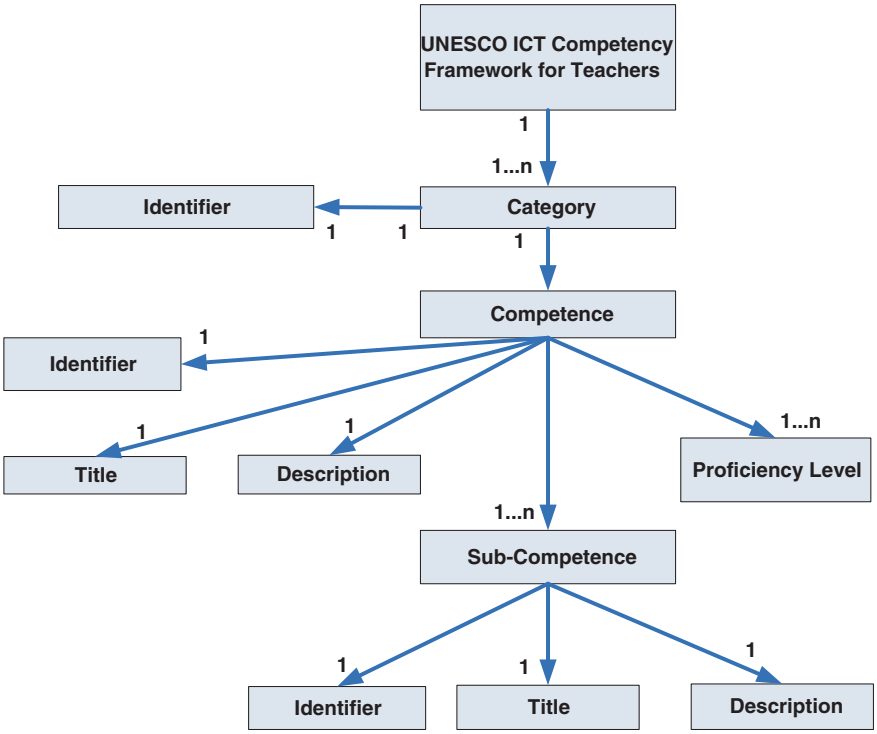

Fig. 10.1 UNESCO ICT-CFT structure

How to represent the UNESCO ICT-CFT and its attributes?

The InLOC specification allows for the description of a competence framework via the element "LOCstructure". This element provides sub-elements for describing the attributes of a competence framework such as: (a) the title of the framework (via the sub-element 'title'), (b) the abbreviation of the framework (via the

sub-element 'abbr'), (c) the copyrights holder of the framework (via the sub-element 'rights'), (d) the date that the framework was created (via the sub-element 'created') and (e) the version of the framework (via the sub-element 'version'). The example below illustrates the use of InLOC specification in expressing UNESCO ICT-CFT and its attributes.

```
   <LOCstructure id="http://purl.cen.eu/unesco">
      <title>  UNESCO  ICT  Competency  Framework  for
Teachers</title>
      <abbr>UNESCO ICT-CFT</abbr>
      <rights>Copyright by UNESCO</rights>
      <created>2011-09-01T00:00:00</created>
      <version>2.0</version>
</LOCstructure>
```

How to represent the UNESCO ICT-CFT Competence Categories?

The InLOC specification allows for the description of competence categories of a competence framework via the element "LOCassociation". This element includes sub-elements for creating relations between the competence framework and its competence categories. More precisely, the sub-element 'subject' refers to the competence framework URI that has been previously defined by the 'LOCstructure', whereas the sub-element 'scheme' is assigned the value 'hasLOCpart' to define the relation between the competence framework and the competence category. In particular, the competence category is assigned a URI by the sub-element 'object'. The 'LOCdefinition' element points to the competence category URI to define additional information about the competence category such as the title (via the sub-element 'title'). The example below illustrates the use of the InLOC specification in expressing the competence category 'Understanding ICT in Education' of the UNESCO ICT-CFT.

```
   <LOCassociation type="http://purl.org/net/inloc/LOCrel">
      <subject id="http://purl.cen.eu/unesco"/>
      <scheme id="http://purl.org/net/inloc/hasLOCpart"/>
      <object id="http://purl.cen.eu/unesco/1"/>
   </LOCassociation>
   <LOCdefinition id="http://purl.cen.eu/unesco/1">
      <title>Understanding ICT in Education</title>
</LOCdefinition>
```

How to represent UNESCO ICT-CFT Competences and the Relations with UNESCO ICT-CFT Competence Categories?

The InLOC specification allows for the description of competences of a competence category also via the element 'LOCassociation'. The element can be used in a similar way as previously described for representing the competence categories of a competence framework. In this case the sub-element 'subject' refers to the competence category URI that has been previously defined by the 'LOCassociation', whereas the competence is assigned a URI by the sub-element 'object'. The 'LOCdefinition' element points to the competence URI to define additional

information about the competence such as the title (via the sub-element 'title') and a textual description (via the sub-element 'description'). The example below illustrates the use of the InLOC specification in expressing the competence 'Policy Awareness' of the competence category 'Understanding ICT in Education' of the UNESCO ICT-CFT.

```
<LOCassociation type="http://purl.org/net/inloc/LOCrel">
   <subject id="http://purl.cen.eu/unesco/1"/>
   <scheme id="http://purl.org/net/inloc/hasLOCpart"/>
   <object id="http://purl.cen.eu/unesco/TL.1"/>
</LOCassociation>
<LOCdefinition id="http://purl.cen.eu/unesco/TL.1">
   <title>Policy Awareness</title>
   <description> Teachers must be aware of policies and be
able to articulate in consciously skilled ways how their
classroom practices correspond to and support policy
   </description>
</LOCdefinition>
```

How to represent UNESCO ICT-CFT Competence Proficiency Levels?

The InLOC specification allows for the description of competence proficiency levels also via the element 'LOCassociation'. However, the sub-element 'scheme' is assigned the value 'hasDefinedLevel' to define the proficiency level of a competence. The relation with the competence is represented by the sub-element 'scheme', which includes the competence URI. Moreover, each proficiency level is assigned a URI via the sub-element 'object'. This URI is used by the element 'LOCdefinition' to define additional information about the proficiency level such as the title (via the sub-element 'title'), an abbreviation (via the sub-element 'abbr') and a textual description (via the sub-element 'description'). The example below illustrates the use of the InLOC specification in expressing the 'Technology Literacy' proficiency level for the competence 'Policy Awareness' of the UNESCO ICT-CFT.

```
<LOCassociation type="http://purl.org/net/inloc/LOCrel">
   <subject id="http://purl.cen.eu/unesco/TL.1"/>
   <scheme id="http://purl.org/net/inloc/hasDefinedLevel"/>
   <object id="http://purl.cen.eu/unesco/TL"/>
</LOCassociation>
<LOCdefinition id=" http://purl.cen.eu/unesco/TL">
   <title>Technology Literacy</title>
   <abbr>TL</abbr>
<description> Teachers need to be able to help students to
use ICT in order to learn more efficiently
   </description>
</LOCdefinition>
```

How to represent UNESCO ICT-CFT Sub-Competences and the Relations with UNESCO ICT-CFT Competences?

The InLOC specification allows for the description of sub-competences of a competence also via the element 'LOCassociation'. The element can be used in a similar way as previously described for representing the competences of a competence

category. In this case the sub-element 'subject' refers to the competence URI that has been previously defined by the 'LOCassociation', whereas the sub-competence is assigned a URI by the sub-element "object". The 'LOCdefinition' element points to the sub-competence URI to define additional information about the sub-competence such as an abbreviation (via the sub-element 'abbr') and a textual description (via the sub-element 'description'). The example below illustrates the use of the InLOC specification in expressing the sub-competence 'TL.1.a.' of the competence 'Policy Awareness' of the UNESCO ICT-CFT.

```
<LOCassociation type="http://purl.org/net/inloc/LOCrel">
   <subject id="http://purl.cen.eu/unesco/TL.1"/>
   <scheme id="http://purl.org/net/inloc/hasLOCpart">
      <label>sub-competence relation</label>
   </scheme>
   <object id="http://purl.cen.eu/unesco/TL.1.a."/>
</LOCassociation>
<LOCdefinition id="http://purl.cen.eu/unesco/TL.1.a.">
   <abbr>TL.1.a</abbr>
   <description>Being able to identify key characteristics
of classroom practices and specify how these characteristics
serve to implement policies.
   </description>
</LOCdefinition>
```

As it is shown, the InLOC specification can fully support the process of describing in a machine readable format the UNESCO ICT-CFT, which is proposed to be used for modelling teachers' ICT competence profile at a European level. As a result, this could enable teachers' ICT competences to be shared with a common format among different systems, which are involved in teachers' continuous professional development, assessment and recognition of competences.

10.6 Conclusions

Within the landscape of the emerging use of ICT in European schools, it seems that there is not a common and systematic way for modelling teachers' ICT competence profile at a European level. As a result, this creates barriers to the process of designing European teachers' professional development programmes that will address universal teachers' ICT competences descriptions among different European countries and facilitate teachers to integrate ICT into their teaching. Thus, in this chapter we set the ground for modelling teachers' ICT competence profile at a European level with a common and systematic way by considering the UNESCO ICT-CFT and we represented it in a machine readable way by exploiting the InLOC specification. The proposed teachers' ICT competence profile could be useful to European Policy Makers who consider teachers' competences as a key aspect for the reform of education and training systems (European Commission 2012).

It is worthy to mention that the results of this study are currently exploited and implemented by a major European Initiative referred to as: 'Open Discovery Space: A socially-powered and multilingual open learning infrastructure to boost the adoption of eLearning Resources'. The Open Discovery Space (http://portal.opendiscoveryspace.eu/) aims to build a federated infrastructure for a super-repository on top of existing Learning Object Repositories in Europe and support the adoption of open educational resources (OERs) from European Schools. As a result, Open Discovery Space aims to facilitate European teachers in acquiring and reinforcing the competences they need to exploit the rich potential of OERs). This is achieved by designing appropriate teachers' professional development programmes, which aim to enhance ICT competences that are based on the proposed teachers' ICT competence profile presented in this chapter.

Acknowledgments The work presented in this chapter has been partly supported by the Open Discovery Space Project that is funded by the European Commission's CIP-ICT Policy Support Programme (Project Number: 297229).

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Part III
ICT in Distance Education

Chapter 11
Changing the Business Model of a Distance Teaching University

The Case of the Open University of the Netherlands

Evert Jan Robbert Koper

Abstract In distance education teachers and students do not have classroom contact, but the education is mainly delivered through distance media. This dependency on technology makes these institutes extremely sensible for changes in technologies: from time to time fundamental shifts in the business model are needed in order to maintain the quality of their offering. In this chapter a case study is presented of a business model change of the Open University of the Netherlands in the period 2008–2013. The triggers for change and the new business model are presented. The implementation of the business model is discussed in terms of adaptations in course development (including the use of Open Educational Resources), course delivery, ICT infrastructure, and a revised model for the implementation of innovations.

Keywords Distance education · Business model · E-Learning · Technology enhanced learning

11.1 Introduction

Due to massive changes in the technologies and its uptake within society in the past 5 years, an enormous pressure is put on traditional distance teaching universities, like the Open University of the Netherlands (OUNL), to adapt their educational delivery systems toward a proper use of these new technologies. To be mentioned are developments in the fields of social media, learning analytics, mobile learning, open educational resources (OER), and massive open online courses (MOOCs).

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R. Huang et al. (eds.), *ICT in Education in Global Context*,
Lecture Notes in Educational Technology, DOI: 10.1007/978-3-662-43927-2_11

In this chapter, I will present the case of the OUNL in its approach to cope with these new developments. The changes in policies will be presented, including the resulting development of new online facilities and the change/innovation processes that it requires to change an institute.

It is important to report about these large-scale change processes in actual practice, because in the literature of technology enhanced learning much is written about the development of new prototypes and small scale experiments, but there are only a few reports about the (management of) change processes that are required to bring the new technologies into institutional use (see also Kearsley 2013). This study could be considered as an exploration toward a future model of institutional, educational transformation processes.

First, the case context will be presented, the OUNL and its drivers for change. This is followed by a presentation of the new business model, including the strategy and project approach that is followed to realize the change. The resulting adaptations in the institute are presented per relevant dimension: changing the business model, the ICT infrastructure, the transformation of existing education, and the creation of new educational services. In the last section, the results are discussed.

11.2 Case Context: The Open University of the Netherlands

11.2.1 The University

The OUNL, founded in 1984, is a public university in the Netherlands providing open and distance education. It is open in admission for its bachelor programs, there are no formal entry requirements. The university provides academic bachelor, master, and PhD programs in various alpha, beta, and gamma sciences. The number of students is ±18.000. The education itself is provided "at a distance": the students are separated in time and place from the teachers and fellow student.

11.2.2 Educational Concept: Guided Self-study

The OUNL uses a mix of, mostly asynchronous, distance media to deliver its education. From its start, the primary educational medium is printed text delivered by post. Additional media like television, CDs and DVDs, email, websites, and mobile solutions have been added later, but mostly as an add on to the printed materials and at a relatively small scale. The core activity of students is to study text materials that are send to their homes or are provided online or, more recently, on tablets. For examinations, they have to go to one of the study centers throughout the country (including some in Belgium). The pedagogical approach of the OUNL is "guided self-study". Course materials are designed very carefully for self-study, most of the guidance is "baked into" the written materials. Guidance by tutors and other advisors is available, although this is optional in most cases

and only delivered on the request of the students themselves. A limited number of students (less than one-third) use the additional guidance facilities.

11.2.3 The Context and Background of Change in 2008

Change was triggered by a variety of observations in 2008. The main five triggers for change can be summarized as follows:

Still in the transition toward online course delivery. The central policy was, from 1997, to promote online learning as the primary delivery mode for new courses. However, in 2008, still many courses where primary print based and although all of them had a course website for more than 10 years, they where in most situations an optional add-on instead of the core delivery channel.

Lack of standardization in the infrastructure for course delivery. Also from 1997, the central policy was (and is) to use one central, integrated set of services to deliver all our courses. The main reason was, except from efficiency in the back-office, to take care that teachers and students have the availability a high quality, secure, complete, and consistent environment for teaching and learning. In 2008, the situation was that there were still many competing, not integrated systems in the university and students are required to switch from one system to the other; as well within courses as between courses. Furthermore, a core component of the infrastructure in 2008 was the LMS Blackboard Learn. An internal evaluation revealed that the use and maintenance of most course sites in Blackboard was below threshold (Van den Boom 2008).

No systematic strategy to implement and mainstream innovation results. Because the research focus of the OUNL is on advancing online distance education, at any moment in time there are many different research and innovation projects exploring the use of new technologies or researching new teaching and learning methods. Some of these projects experiment within the OUNL context, sometimes at smaller but sometimes also at larger scales. Examples of projects are the use of mobile technologies, of language technologies, the implementation of a new digital skills labs (Nadolski et al. 2008), the development of a new corporate website, the use of itunesU and Youtube Edu, exploring the use of eReaders (later tablets) and new facilities to monitor student progress. Among these projects also larger-scale EU project were executed, like the EU-Integrated Project TENCompetence, a project that researched and developed an approach, including software for the support of lifelong learning (see Koper and Specht 2006; Koper 2009). The problem in 2008 was: how do we turn successful research results into successful use within our own institution? Most of the implementations of these projects were limited in scale, only used within a few courses or some faculties. No maintenance, continued development or support was foreseen after the project period. Furthermore, it was unclear how all of these solutions would fit in an overall strategy and architecture.

Discussions about the strategic position of the OUNL within the national university landscape. This discussion has started around the year 2000. Regular, residential universities were also using e-learning to a certain extent and also the number of students at the OUNL where decreasing and drop-out was too high. The question was:

what should be the specific role of an Open University in a landscape where residential universities are also delivering distance education? What should be our market position, target groups addressed? Several answers are given at that time with attributes like: adult education, online education, continuing academic education. The main umbrella became the concept of "lifelong learning," more specifically upgrading the professional workforce in the Netherlands toward academic degrees. So, the role of the OUNL would be to provide academic lifelong learning: the facility to attain a bachelor or Master's degree in any phase of your life and to keep up to date with your profession or discipline of interest. In order to be able to deliver a broad range of learning options, it was also required to collaborate with other universities. The OUNL would then position itself more in a broker role, integrating the online offering from various academic institutions through a single point of entry for students.

Searching for a strategy to position Open Educational Resources within the system. The use of OER was motivated by a strategy statement made in 2005: when the central government compensates the OUNL for the loss of student income (about one-fourth of the total university costs), all educational self-study materials could be made available for free at the Internet. These high quality in-house developed materials could then be used by individuals and other universities to enable massive participation in higher education. This would strengthen the economic position of the Netherlands and would redefine the role of the OUNL as the public provider of academic (lifelong) learning opportunities for all citizens in the Netherlands. The OUNL participated in OER projects, resulting in the provision of some open courses. In 2008, several open courses had been developed and delivered to the public (Schuwer and Mulder 2009), but they were offered on a separate platform and where not integrated properly in the OUNL's degree programs. So the question was: how could we position OER as an integral part of our business model.

In order to cope with this rather challenging situation, in 2008 a new strategy plan was formulated and agreed upon at the level of the Board, Deans, and Directors. The main objective was first to fundamentally renew the business model and adapt the infrastructure accordingly. In the following paragraphs, we will focus on this change of the business model.

11.3 The New Business Model

11.3.1 Approach and Aims

A task force was established to develop the new business model. The approach developed by this task force was the following:

- Given the constraints of a public university and the national economic situation, it is not likely that the OUNL will be financially compensated by the national government to provide all of its courses for free. Furthermore, there is no sound business model available that can be used by a public university: it is impossible for a public body to compensate for loss of income with market activities like selling user-profiles, adding commercials or attracting venture capitalists.

- Instead of providing all resources for free, a more sustainable business model would be to establish a subscription system for academic education along the lines of online services like Spotify or Netflix. For a fixed, small amount per month, subscribers should get free access to all courses and be able to study them to update their professional knowledge. A concentric circles model was developed, specifying the access rights of different user groups: OER users, users interested in continuing education and students in degree programs. This model will be explained in more detail in the next paragraph.
- In order to realize this ambition, all courses should be delivered online, including all the in-house developed materials and the additional educational services that are added. The access rights of all materials should be organized according to the concentric circles model and it should be easy for teachers and others to set and change the access rights for each course element. In this way, materials in degree programs can be made available as OER or within the subscription model with just a simple "press on a button."
- Besides the OUNL, other institutes for higher education could participate to deliver their online courses through the same infrastructure. In this way, creating a single entry point for academic lifelong learning in the Netherlands.
- In order to stimulate social learning processes like knowledge sharing, peer collaboration, and contacts between experts and novices in a field, social community functions should be established and supported in the infrastructure.
- And, last but not least: it was a deliberate choice to integrate all the products and services from the OUNL and external providers through one integrative entry point for end users (a "portal"). In this way, it is easier for users to search and use the system.

The ultimate aims identified in the strategy plan of 2008 can be summarized as follows:

1. the renewal of educational offering to attract new target groups;
2. promote retention/prevent drop-out;
3. more efficient course development;
4. increase the visibility of the OU research and education in the Dutch society;
5. integrate the use of OER within the business model.

In order to implement this strategy, an innovation project was installed: the OpenU project (2009–2013). In the next paragraph, the concentric circle model is presented, followed by the requirements for the project and the management of the innovation process.

11.3.2 The Business Model: The Concentric Circles Model

Business models can be described in different ways. In the strategy planning, we used the business model canvas of (Osterwalder and Pigneur 2010), see Fig. 11.1.

The core aspect in this model is the value proposition that is created for the customers through the infrastructure and the resulting costs and revenues. The new

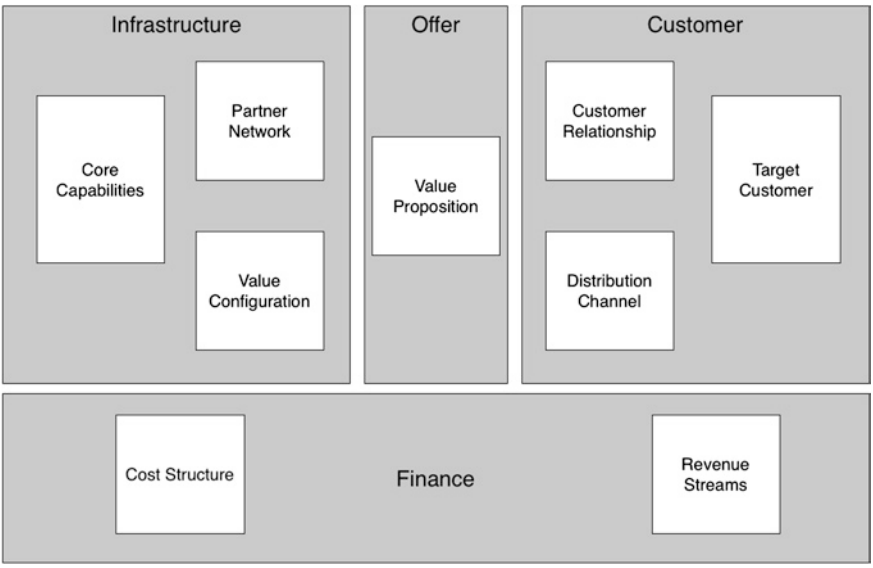
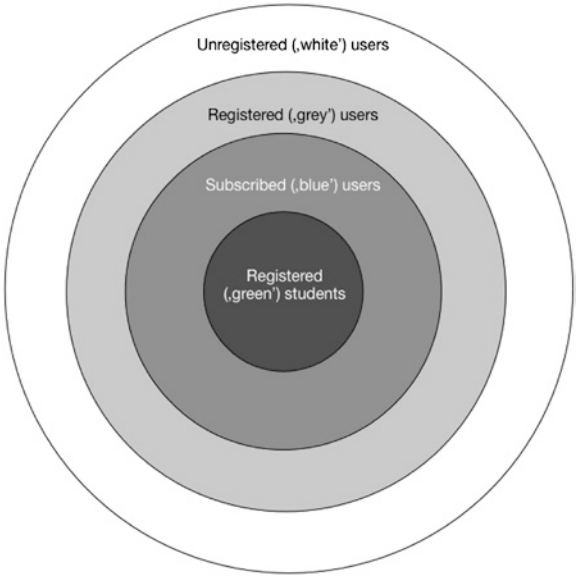


Fig. 11.1 The business model canvas

Fig. 11.2 The concentric circles model



business model of the OUNL is described through the "concentric circles model" that brakes down the target customers into four groups, each offered different educational products and services for a different payment scheme (Fig. 11.2).

The first group ("green users"), are the students that are enrolled in the various Bachelor, Masters or PhD programs of the OUNL. This is the core target group

of the university. The offering, the quality, the enrollment and financial compensation are all regulated by national laws, checks, and services. The next circle ("blue users") represents post-initial, continuing education. It is aimed at people who want to update their professional knowledge in the field. This group will be offered a subscription for one or more academic disciplines, like informatics or educational sciences. The challenge is that they should be offered sufficient new and up-to-date learning opportunities to attract them for a long period in their careers. The third group ("gray users") is meant for people who want to explore whether a subscription program or studying for a degree program at the OUNL fits their needs and is attainable for them. They are offered free courses and resources (OER), but they need to register (for free) in order to be able to access them. For most open courses, like MOOCs, this is needed in order to keep track of progress, use the social functions, use of notifications, etc. The last group ("white users") are people who are interested in the OUNL and the educational resources that are offered for free without registration. These resources are indexed and searchable through search engines and can point people to the OUNL when they are searching for learning opportunities.

One of the possibilities would have been to create services for each of these groups separately. However, in the business model this is designed as concentric circles, meaning that people in one of the middle circles automatically have access to all services offered to the outer circles. For example, a person from the blue group, also has access to the facilities offered to the gray and white users. Students (green users) have access to everything offered. Table 11.1 provides an overview of the products and services offered to the users in the different circles.

Table 11.1 Main products and services delivered to the green, blue, gray, and white user groups

Product/Service	Users				Access restrictions
	Green	Blue	Gray	White	
Information and orientation facilities, including open access materials (research papers, master/PhD thesis, access to research communities ('topics')	x	x	x	x	Open access
Open courses, social network tools (including user profiles and tools for knowledge exchange)	x	x	x		Free access, registration is required
Subscription program, including access to all digital course materials in the selected academic discipline	x	x			Access for a monthly subscription fee
Access to tutoring and examinations within the degree programs	x				Enrollment as a student and payment of the regular tuition fees

11.3.3 Project Assignment

The assignment for the OpenU project was the following:

1. Develop, test and implement the business model, including the ICT-services to deliver the required functionality as specified in Table 11.1.
2. Create functionality for rapid, collaborative online course development and delivery, integrating resources from other systems, like LMS's and the student administration.
3. Develop a solution that enables a course developer to change the access rights of parts of the courses to any of the users in the concentric circles model. In addition to this it was stated that about 10 % of all the digital materials of the degree courses should be made available as OER.
4. Develop a learning analytics approach to monitor student progress and provide aggregated and individual feedback about performance to students, tutors and managers.

11.3.4 Management of the Innovation Process

Innovation projects like OpenU involves a complex management process. The approach followed was based on modern innovation approaches like the cyclic innovation model (CIM; Berkhout 2000).

In these modern approaches, innovation is seen from a systems perspective and not as a linear diffusion process (cf. Rogers 1995). In CIM, innovation is the result of close interaction cycles between research, technology development, product creation, and market transitions. It integrates technology innovation and social innovation. The innovation method used in the project can be summarized as follows:

1. First of all complexity was reduced by involving only two of the seven faculties of the OUNL: Informatics (1,500 students; 1 bachelor and 3 master programs) and Educational Sciences (652 students; 1 master program). The idea was that after a successful implementation phase in these two faculties, the business model will be implemented in the other faculties. The two faculties where chosen on the basis of multiple dimensions, like the variance in the target groups and some practical concerns about staffing and resources.
2. Close connections and collaboration were established between all relevant stakeholders involved: researchers, technology developers, ICT maintenance, educational development and delivery, students, teachers and managers. Also, more distant stakeholders were involved like the ministry of education and student and employee representatives councils.
3. The users in the two fields (existing students, but also new target groups) should be involved as soon as possible. This was done by developing the ICT facilities and educational services incremental. In only 2 month of preparation a first website with offering should be made available, people can participate

and the project can evaluate users needs and behaviors. The strategy was to start with the easy functions and release more complex functionality later in the process. So, the idea was to start with the services for the white user group, followed by gray, green, and then blue. The facilities for the blue users were considered to be the most complex and innovative.

4. The design of the approach should build on the results of contemporary research and developments. One of the main inputs was provided by the TENCompetence project (Koper and Specht 2006), providing the fundamentals for the development of the ICT framework and the educational services to offer (for an overview of the research articles published in this project see hdl.handle.net/1820/496). Based on the experience in the TENCompetence project, the software framework selected as a base for development was the Liferay Portal platform (liferay.com). The software development methodology selected was SCRUM (Schwaber 2011).
5. The work was divided in several sub-projects: new service development, ICT development/maintenance, help-desk, training, marketing, course conversion, development and delivery, testing.

11.4 Adapting the Distance Education System

11.4.1 Adapting the ICT Services

In March 2010 the first version of the portal openu.nl was released focusing on the services for the white and gray user groups. It contained subportals for both the Informatics and the Educational Sciences faculties, along with a first version of a user profile and social software functions. The main ICT challenges in the first releases were connectivity with the existing infrastructure like the identity management system for single logon. This was not complex from the technological perspective, but mainly because there were many stakeholders involved within the OUNL, each with their different projects and priorities. Following the SCRUM process every three weeks there was a release planned. Users were actively asked for input through different means: questionnaires, help-desk, personal contact. User behavior was followed through logging of user behavior (e.g. using Google Analytics). The main functions developed are:

1. A personal *dashboard* that presents the various courses, programs and websites the student is subscribed to. The dashboard can be rearranged according to user needs, much like apps on a mobile platform. The apps provide push information about important events or messages from the courses or websites they represent. This provides an overview of the learning activities, important events and the learning path for the students (also see Janssen et al. 2008; Janssen 2010).
2. A *catalog* of the total offering from multiple vendors. This functionality is much like a web-shop. People can search and subscribe to courses and

websites. Each item has one or more prices attached. For instance: one can enroll for a regular OUNL course in a degree program, but also see the free version of this course or enroll for the subscription program (blue user).

3. A *credit point and voucher* system. People can earn or buy credit points that enables them to subscribe to some services like online masterclasses and conferences. Vouchers with credit points can be emailed and carried over to other users. This is especially important in corporate settings where an employer buys a couple of vouchers to be distributed among employees who can use them to register the credit points in the OpenU system. With the credit points they can enroll in online masterclasses or pay the subscription program.
4. A *collaborative course development* system in which the author can control per item the access rights for user groups given the concentric circle model (see Fig. 11.3). This system is used for the development and delivery of online courses as well as for online masterclasses, MOOCs and research communities. It works alongside the standard wiki function of Liferay. The wiki is used to collaborate on the development of course content. The course development system also includes the authoring and delivery of tests as well as a workflow system for assignments.
5. A *user profile and social system* in which users can specify their interests, can find and contact each other, can blog, maintain a personal wiki and manage files. Also connections to Facebook or LinkedIn can be established. Every item

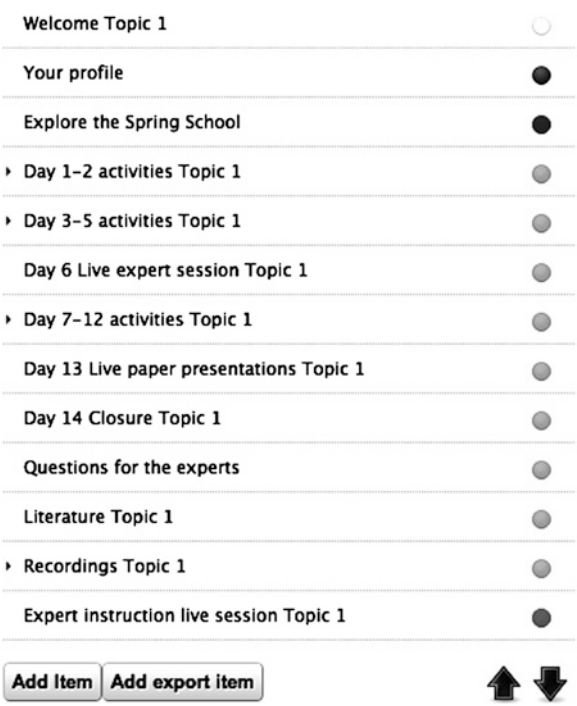


Fig. 11.3 Controlling the access rights for course items: the *colored bullets* use the colors of the concentric circle model. Example: the *gray users* can only access the item 'Your profile'. Clicking on a bullet will change it color and respective access rights

posted in the system has a link to the user profile of the author (see Hermans et al. 2014 for an overview).
6. A learning analytics system that is used to monitor the progress and the activity of individuals as well as groups of learners. It contains information from various sources, e.g., the student administration and the progress within courses, logging data as well as information from the activity stream of Liferay.

Dedicated learning network services, like the possibility to annotate, tag and bookmark resources for later reference (Hermans et al. 2011).

11.4.2 Adapting the Business Model

The ICT infrastructure supports the intended change of the business model. In the Educational Sciences faculty several services for green, blue, gray, and white users are developed and maintained using the OpenU infrastructure. Offerings for the white users includes:

- 10 % of the regular courses are offered as OER (free access for white users, using the access system of Fig. 11.3);
- a portal with an overview of all study facilities, research outputs and job possibilities in the educational sciences;
- a series of eight research topics that are directly connected to the core research groups within the OUNL. These topics have introductory texts about the research field, the main theories and main literature. The members of the team and interested students publish blogs about these topics and organize one or two online masterclasses each year per topic. The research topics are: Learning Analytics, Information Literacy, Networked Learning, Expertise Development, Mobile Learning, Effective Learning Strategies, Cognition, Lifestyle and Learning and Serious Gaming.

The gray users are offered the same as the white users, but with the addition of social tools (user profile, personal blog, wiki, etc.) and the possibility to interact, e.g. provide comments on the content.

A subscription system for the blue users has been realized. The subscription was designed as follows:

1. People subscribe for a learning trajectory in the educational sciences, called "learning and teaching in the twenty-first century." Subscription is for 1 year. The content of the trajectory changes continuously; people are offered new learning opportunities every month. The idea is that they maintain their subscription many years ("lifelong") to keep themselves up-to-date in their profession. The main target group is teachers and managers interested in the innovation of education.
2. They are offered six vouchers with credit points that they can use to access six online masterclasses from the total offering in a year (about 12) and they can access the archive of online masterclasses.

3. They have access to all digital course materials of the online MSc program in the Educational Sciences. They are able to make assignments, but they cannot send them in for feedback or grading. Peer feedback in the community can be asked.
4. After a year they are offered a certificate of participation, specifying the number of study hours they have spend on various learning activities. They can bring in external learning activities, however they should offer some proof. The certificate does not specify the attainment of any learning objective, but specifies the type of activities and the number of hours spend. Every hour is equivalent to exactly one PE (Professional Education) point. Some professional organizations in the Netherlands require professionals to attain a certain number of PE points per year and agreements have been made with such a public organization to accept the PE points provided from OUNL. PE points can not be converted to EC (European Credit) points that are needed within degree programs, although they can serve a role in the assessment of prior experience, e.g., for exemptions in degree programs.

The MSc program in Educational Sciences has been transferred from Blackboard Learn to OpenU in July 2011. This included a more advanced monitoring system based on learning analytics principles. Students can complete individual tasks and teachers can follow individual and group processes in the context of the available data like: activity stream, student administration data, completion dates, date last login, etc. Furthermore, the workflow for submitting, grading and feedback has been better integrated within the course structure. Because it was a straightforward conversion, social tools and functions were not added in the first run, but are now slowly integrated more and more in the different courses.

In the Informatics faculty the facilities for the white and gray user groups have been elaborated extensively, but the subscription program for blue users is not open yet, although it has been designed and worked out. The design of the subscription system is a bit different, mainly because the distance teaching model of their course offering is different. They offer mainly printed course materials. In informatics, subscribers get access to the read-only PDF versions of the course materials. The idea is that this is of interest for alumni to keep up-to-date in the rather fast changing profession. They also introduced the community tools and some webinars are organized. Facilities for regular students (green circle) are not yet integrated. The reason was that it would be too much work to change from the written delivery of course content to online teaching. This can be done later, when the degree programs are revised.

11.4.3 Adapting Existing Education

As stated before, the MSc program in Educational Sciences, including the pre-master program has been converted from Blackboard Learn to OpenU. In total, 25 courses (except the thesis course all have a study load of 120 h; 4.3 ECTS) have been converted. This has been done in 5 days with the tutor team, the program management

and the OpenU team, including testing, further standardization of the structure of the courses and the conversion of all the digital course content. The process went smooth, and the authors have found the new authoring environment easy to use.

11.4.4 Adapting the Educational Services

The conversion of existing courses to the new platform does not reform education or its business model more fundamentally. Based on the ideas worked out in the TENCompetence project, the functionality of the OpenU platform is designed to implement solutions that provide fundamental new ways of teaching and learning. Some new educational concepts have been designed and implemented using OpenU. This includes: the setup of pedagogically advanced MOOCs, the concept of online masterclasses, the concept of learning trajectories for professional development (PE points), the establishment of online research topic communities that bring scholars and interested students in direct contact, the 10 % OER that is derived from regular courses, comments of students on designed course content, intensive monitoring of student progress in order to realize more proactive teaching modes in distance teaching, the use of social functions (searching fellow students, exchanging knowledge/experience online, debating research issues, etc.). Furthermore new types of guidance and pacing where explored using OpenU, so called Sprints and OUX. Sprints are optional tutoring facilities within a course for students who want to increase their speed of completion. OUX courses are optional tutoring facilities that help students to run in a fixed tempo through a series of courses. The problem of dropout and the need for more pacing has led to the development of a new strategy plan for the redesign of all the education within the OUNL. This process has its first deadline in 2015 to adapt and change all master programs of the OUNL.

Besides innovations that are already tested, there are many areas that are not yet explored sufficiently, to be mentioned:

1. Systematic exchange of knowledge between participants, e.g., solving real world problems.
2. Collaboration in course content development between students, external experts and teachers. The course content is stored in a wiki format, enabling this collaboration.
3. Alerts and warnings based on student data that are available in the system: as well for the students themselves as for teachers. Examples are automated alerts when students are behind schedule or when teachers are not responding fast enough to student requests.
4. Exploration of new pedagogical models, mixing the principles of regular courses with more social, collaborative approaches.
5. Using the learning network as a peer support network to increase the support facilities without increasing the teacher load (Kester et al. 2007; Rosmalen et al. 2008).
6. The integrative use of the system in the context of skills training through serious games (Nadolski et al. 2008).

11.4.5 Use of the Services

At the moment (September 2013), there are 19.829 registered users in OpenU (Fig. 11.4) of which 12 % has created a user profile (adding a photo and/or additional information about yourself).

The Google Analytics data in the period September 2010–September 2013 for the two faculty portals were as follows:

Educational Sciences: visits: 153,340; unique visitors: 91,104; returning visitors: 59.4 %.

Informatics: visits: 245,604; unique visitors: 165,345; returning visitors: 67.4 %

The results of a recent user survey are as follows (Verstappen 2013). A questionnaire was send to 1546 registered users, of which 291 responded between 18th of March and 15th of April 2013. The use of the various services is summarized in Table 11.2.

In total, 31 online masterclasses have been organized from Sept. 2011 to Sept. 2013 and in addition around 10 online webinars were delivered. A first MOOC in the Dutch language is running at the moment with 700 participants in the

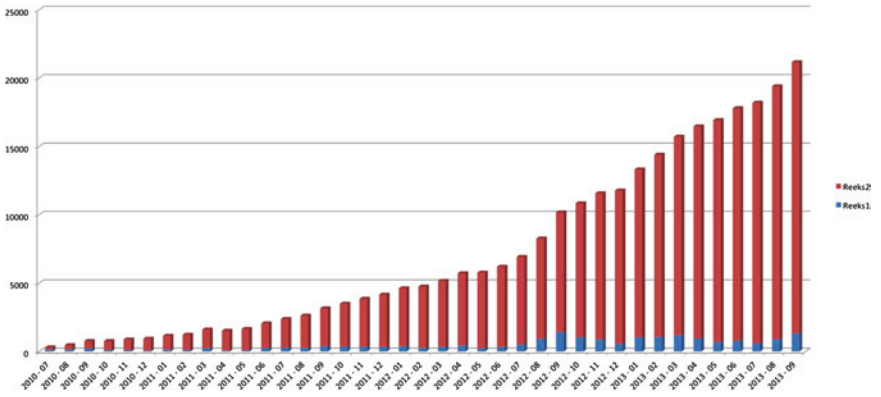


Fig. 11.4 The development of the number of registered users in the system (registration was open from July 2010)

Table 11.2 Use of the various services

Service	*N*	%
Online masterclasses	101	44.5
Topic communities	97	42.7
OUX	35	15.4
Online courses	181	79.6
Created user profile	139	61.2
Social contacts	57	25.1
Blogs	44	19.4

Educational Sciences. The MOOC integrates a couple of online masterclasses that can also be followed individually.

The subscription program in the Educational Sciences at the moment attracted 144 persons. Both the total number of students in the Educational Sciences and in Informatics degree programs is increasing from 2010 onwards. This compared to a context where all other OUNL faculties, except Law, are decreasing in student numbers.

11.5 Results and Impact of the Use of This New Model

In this section we are looking back on the original strategy aims as they were defined in 2008 and the results and impact on the distance teaching system.

11.5.1 The Renewal of Educational Offering to Attract New Target Groups

The OpenU project successfully delivered an infrastructure for two faculties. The implementation for Educational Sciences was complete (including products and services for all four user circles) and for Informatics only for the white (non-registered) and gray (registered) user circles; although in the latter case, they were much more elaborated. The difference is because Informatics viewed the OpenU facilities mainly as marketing facility for their existing educational offering. In the Educational Sciences the educational offering was also renewed.

In the Educational Sciences, new target groups are attracted, mainly by the new online masterclasses and the subscription system. In Informatics less has been done to renew the offering, but the student numbers are increasing as well. Whether this can be attributed to OpenU is hard to measure. A big difference with the past situation is that OpenU stimulated direct contacts between all participants: teachers, students, external experts and (prospective) students and lifelong learners. Distance teaching has become less distant. The interaction does not come spontaneously by just putting the ICT facilities in place. It is necessary to organize learning opportunities like masterclasses, webinars, research topics and online courses in order to stimulate the online interactions between users.

11.5.2 Promote Retention/Prevent Drop-Out

In the Educational Sciences, one of the main advantages that teachers and managers see in the new OpenU facilities is that they are able to follow progress of students by means of the new learning analytics facilities. However, this also requires that teachers are more pro-actively following students and take actions

when something seems to go to the wrong direction. This is done more and more by the teachers involved, but is not given automatically by installing the technical facilities: also proper management and coaching of the teaching staff are needed. OpenU has also been used to experiment with a new, more structured form of distance teaching. Based on the need to increase student retention, we have developed a plan to revise all education in the coming years.

11.5.3 More Efficient Course Development

Based on the fact that a whole online MSc program could be converted in a couple of days and the fact that many of the courses have been revised, updated or renewed in the meantime, we can conclude that authors can use OpenU for course development in an efficient way. However, most efficiency came from the following aspects. First of all OER materials are not developed anymore separately from the online degree courses. They are directly derived from them by setting some access rights on the full courses. In the second place, not all course materials should now be developed in advance. They can be developed also during the run of a course. In this way, course development can be more adaptive to the experience and needs in the course run; development and exploitation are not so divided as they were in traditional distance education. A third factor is that existing courses can be adapted easily to a new target group, and last but not least, the OpenU facilities support strong collaboration on course development, even involving students or external experts. Involving students has not been done to a large extend yet, however more and more students are now commenting on specific course pages when they want to add something, see a mistake or have a question.

11.5.4 Increase the Visibility of the OU Research and Education in the Dutch Society

The online masterclasses that are organized by the research groups and the topic communities that provide an insight in the latest developments in research are now important instruments to increase the visibility of research. The visibility of education is also increased, especially by the work in the Informatics faculty to build their website as a showcase for their study programs, including the free accessible (OER) samples. We came across a difficult problem here: the relationship between the corporate university website and the OpenU website: what should be offered in what site and how do they relate? This problem will in the future be solved by merging both websites, especially the website content for the white and gray users. The corporate website however should be redesigned to offer functionalities like the dashboard. First steps in this direction are already taken, but it is expected that it will take at least a year for a better integration.

11.5.5 Integrate the Use of OER Within the Business Model

OER is used integral within the offering of Educational Sciences and Informatics. The development is directly connected to the core business in the Educational Sciences, because it is derived directly from the existing online courses. Also many of the online masterclasses and MOOCs are offered for free. External public parties also sponsor some of them so that they can be offered as OER. The system is developed in such a way that the percentage of OER offered can vary according to circumstances which makes it very flexible. These technical solutions, however, do not stop the more political discussions about the question to which extent OER, especially MOOCs, should be offered by (public) universities. Should there be a national action plan? What about the level playing field with commercial providers in the Netherlands?

11.5.6 Innovation Process

What is the reflection on the innovation process that has been followed? How do we proceed from now by implementing the new products and services within the rest of the university, including the support departments? These questions turned out to be one of the most difficult questions. The faculties that did not participate, invested in some other innovations that are not in line with the general agreed upon strategy. Also, although they were formally connected and informed about the process in established boards, they were rather distant to the project ('wait and see'). The same is true for the support departments: for services during the project they are payed. After the project they are required to organize the support as part of their regular services. This restructuring requires to de-prioritize other regular activities and they should train staff and reorganize. This is a hard process, so resistance to these changes is expected. So, for future projects questions like the following should be answered. Is it a good idea to concentrate on only some faculties instead of all? Should such a fundamental new service be build outside of the running business and not integrated with it? How could we improve the 'landing' process within the service organizations?

11.5.7 How Far Are We?

Are we anywhere near the idea of transforming the OUNL to a kind of Spotify or Netflix for education as was intended in 2008? The simple answer is no, not yet. Although this route is still very worthwhile to explore, there are many problems to solve first. Not discussed so far, but in OpenU also courses of external parties were developed and provided. Because of an overfull agenda of activities in further development and experimentation with new services, this did not had a high priority yet. Also for various reasons it is hard to collaborate with other parties in this way. Most other providers do not have the experience and organization as distance

education institutions have them to develop high quality online education. So, to the contrary of the offering of Spotify (music) and Netflix (film), most of the content itself does not exist yet and should be created first. Furthermore, courses are not like music of films: they cannot be copied as easy to almost no costs. Each time they should be organized, and involve teaching staff. For the OUNL this means that the institute will first focus on the further internal implementation, the changes in the internal organization and the improvement of its own educational products and services.

11.5.8 Towards a Model of Institutional Change in Education

As stated in the beginning, case reports about institutional change processes in the field of technology enhanced learning are rare. Educational innovation projects have difficulties in finding the right innovation management approach, as was illustrated with the questions asked in the previous sections. Maybe it is worthwhile to work toward a model for institutional, educational transformation: a model that can be used as a guide to arrange educational innovation projects and processes successfully. I see at least five core questions that should be addressed in such a future model:

1. The system boundaries: what is controlled within the educational institute and what factors represent the relevant external world?
2. What are the relevant performance variables of the institute and how to measure them?
3. What are the relevant input and context variables, e.g., laws, budget, tasks and targets, etc.?
4. What is the business model of the institute, i.e., how does it attain performance with the constraints given?
5. When the aims of the organization are changing or performance is below threshold, what is the best approach to change the business model of the institution, given its context variables?

The first thing needed, however, to develop such a model is enough case studies that can be studied in meta-analysis.

Acknowledgments In a process described in this chapter, many people at OUNL were involved. Without mentioning any specific names I especially want to acknowledge the contribution of the OpenU team, including the teams at the Infomatics faculty and the Master Program in the Educational Sciences; furthermore the Board of Directors of OUNL and my fellow Deans in the faculties.

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Chapter 12
Capacity Building Models Through Distance Education

Carlos A. Villanueva and Marcia Ortega

Abstract This document addresses three examples of success cases on distance education within (a) an important financial group with presence in Latin America and Spain, (b) a nongovernmental organization based in Europe, and (c) a government department in an African country, through programs jointly designed with a prestigious Mexican higher education institution. Challenges faced by the involved parties will be presented, such as the translation of training needs to specific educational objectives, quality contents, and delivery methods, in addition to the participants profile diversity, ranging from education and organizational level to cultural, technical, and socioeconomic level differences. As a result of these projects, robust tailor-made programs were developed or are currently in process of being developed, supported by experience-based learning, well-defined objectives and subject areas, a carefully conducted instructional design, and the use of innovative online education technologies, which have an impact on the lives and jobs of thousands of people.

Keywords Capacity building · Continuing education · Distance education · E-learning · Instructional design

12.1 Introduction

Nowadays continuing education has been benefited from different teaching delivery channels and methodologies that involve experience-based learning and distance education. Given the conditions of a more practical education, organizations must

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R. Huang et al. (eds.), *ICT in Education in Global Context*,
Lecture Notes in Educational Technology, DOI: 10.1007/978-3-662-43927-2_12

be capable of recognizing their training needs, scope, and objectives, so that, hand in hand with new technologies, programs more aligned with the company and its personnel development requirements are created. However, not only executive education can take advantage from the benefits of online education, as we will look over in the following sections.

This chapter addresses three cases of continuing education using distance education within (a) a large *financial group* with presence in Latin America and Spain, (b) a *nongovernmental organization* based in Europe, and (c) a *government department* in an African country, through programs jointly designed with a prestigious *Mexican higher education institution*.

Whereas the financial group training program is already fully developed and successfully running, and the NGO's and government department's programs are still a work in progress, they all have gone through several planning stages defining what their most urgent training needs are, for a subsequent program design and development.

The reader will get examples of how online education must be planned, thought, and developed under a series of relevant parameters such as needs detection, goals to be achieved, definition of the audience, and evaluation models, all of it along with methodological tools and models that allow the participant to truly live an experience-based program.

The presented cases are themselves product of the experience of the authors' role in the described processes and, since they are part of major projects within their own context, the identities of the aforementioned organizations and extended details remain undisclosed.

12.2 The Financial Group

The financial group, with headquarters in Spain and presence in Latin America and the United States, was looking for a training solution given some recently found issues. The Mexican university was their best option, taking into consideration its prestige and the 20 experience of its distance education area. The next segments address the followed process.

12.2.1 Training Need and Tailor-Made Programs

The financial group detected, within a particular business area, some problems worth focusing their attention, such as high staff rotation, lack of commitment, and low sales of a specific product. It was very clear for the group, at this point, the need of a training program which main goal were to provide the personnel with tools to get the required skills, transforming this area of opportunity into a strength as a consequence.

Along with a clear goal definition for the training program, the organization had to take into account the peculiarities of the target audience. The group was

heterogeneous enough in several factors such as age, seniority, educational level, and cultural background (granted that there were five countries involved), for being able to, in addition to achieving the academic objectives, develop a program that complied with the varied expectations and was inclusive with the particular needs of each represented country.

Before this scenario and, despite that they were aware of their position as a market expert company that had enough information for training their own employees, they realized they needed the support and orientation of an educational institution which experience bring them the appropriate methodologies and delivery channels for the program.

When having the first conversation with the university, defining the apparent problem, and in the coming and going of ideas, several program drafts came to light, looking to meet the established goals. The stages followed were related to:

- Objectives definition
- Participant profile
- Program characteristics
- Methodological model and didactic proposal
- Program curriculum
- Content development
- Evaluation and certification process

Being this as one of a kind program, company and university worked very close together; the first one providing all of its experience in the specific matter, and the second one designing and developing a training program that offered the participant experience-based learning through innovative educational technologies.

12.2.2 Program Development

One of the main characteristics of the program, which turned it into a major challenge, was the cultural diversity and the heterogeneity of needs that each country presented. Because of this, the university proposed a program which implementation model was held by levels within the organization (position chart) and divided into subject matters (areas to develop, abilities, and knowledge) previously set by the bank. Within each level, there were general courses for the entire audience and specific ones by country, depending on the policies and subject areas affected by them. Each part of this practice is detailed next.

12.2.2.1 Objectives Definition

In order to achieve success in any training program it is necessary to determine its objectives the right way. In this case, field work and diverse discussion sessions were held with the institution to get to better know the specific needs expected to

be met by this program and its scope, taking special care of the alignment of said objectives to those of the company.

12.2.2.2 Participant Profile

In addition to the relevance of generating clear objectives to all the involved countries, considering the peculiar characteristics of the varied student profiles was a defying task. For the first phase of the program, the group was expected to be of over 2,000 students, distributed in Argentina, Chile, Colombia, Mexico, and Peru. Added up to this cultural mix, there also was the disparate academic degree factor; thus the need of developing, as mentioned before, a program conducted by levels itself: basic, intermediate, and advanced. It was possible, through this arrangement, to assign the participants to their corresponding academic level and, at the same time, in accordance to their position within the company. This approach, besides providing the participants with specific abilities and knowledge, seeks to be an incentive so the staff makes the effort to accredit the levels and aspire to a better position within the organization.

12.2.2.3 Program Characteristics

With the goals and participant profile already defined, the next step in the program development was to determine the distinctive features to support the goals achievement, considering the type of students being addressed. The online format was thought to be ideal because, in addition to all the benefits offered by the information technology, the fact of having such a large and disperse audience across five countries, required a highly flexible format which allowed to integrate all critical subject areas related to the participant's level; thus coming up with a program of around one hundred online training hours, covering the company's five strategic themes and addressing them according to the participants' level and their growth plans within the organization.

12.2.2.4 Methodological Model and Didactic Proposal

In accordance to the established objectives and time frame for the program, the proposed learning process cycle was centered on a general didactic strategy consisting of triggering situations. Such triggering situations were the core component in the content design and development, enabling the students to understand the topics, within a context applied to their actual work life. The courses have a direct application in the participants' labor environment, depending on their region and country. They also have discussion forums per content module; these are regional forums to make their operation easier. During the entire program, students have the support of tutors, who help them with technological questions and guide them through general aspects of the courses. They also count with the assistance of expert tutors, who answer more focused questions regarding a particular topic.

12.2.2.5 Program Curriculum

Once the program structure, goals, and methodological models were defined, an expert team on instructional design from the university laid out the curriculum, having as basis the five strategies needed to be strengthened in the participants. This curriculum had to be evaluated by both the financial group's corporate training team and by the human resources area from every participating country. This effort demanded from the educational institution to conduct field work in each country in order to revise the academic content of the entire set of courses. The result was a continuing education program with a specific focus and, at the same time, regional courses that, given the particular circumstances of each country regarding policy and legal aspects, required special treatment.

12.2.2.6 Content Development

The program curriculum required the work of a group of experts: experts in instructional design from the university, experts in the subject areas for content development, and closely collaborating with experts from the financial company, since all topics were approached from the labor reality of the participants.

For course production, the educational institution outlined a work scheme where company, university, and topic experts developed contents hand in hand, both general and specific courses by country. Taking advantage of the university's reputation, they invited a renowned American institution, world leader in the program topics—sales, finance, and organizational process—to join the task, hence achieving a synergy between company and higher education institutions. Once the contents were ready, they were reviewed by a human resources representative from each country, in charge of validating and, in some cases, suggesting additions in order to complement them. After this, contents were officially authorized for later instructional design, graphic design, and web programming within the university's technological platform.

12.2.2.7 Evaluation and Certification Process

With the program's basic elements already in place, it was necessary to also define an evaluation process for the participants' certification. The student would take an evaluation per course and per level, so that the ones who had the abilities and knowledge applicable for a certain position, might have the option of taking an accrediting the tests, therefore enrolling only on the required levels. Once all the evaluations are appropriately passed, the participant is deserving of a certification for the entire program. It is worth mentioning that these evaluations, same as the contents, were validated by the countries involved and the corporate offices, so that they were as inclusive as possible.

12.2.3 Program Start

All of the stages of planning, organization, and curriculum development, took a 12-month period and in August 2008 the program was formally announced through all the company, being extremely well accepted among the personnel. Employees interested in being a part of this experience sought the support of their regional human resources area and became candidates to join the program. The selection process was carefully carried on by staff in directive positions, whom, based in the candidate's profile and development plan, finally picked the ones with greater potential to make the best out of the resources and opportunities offered by the program. The first cycle of the program had a registration of 2,046 students.

12.3 Results

This program has been very successful since the beginning, with thousands of candidates applying—in the first generation, 2,046 students were enrolled (Table 12.1).

It has been, in fact, the most successful program in the history of the financial group, to the point that its model has been replicated for covering other training topics/needs within the organization. This program has been the most demanded by the employees, and its popularity has brought in three more countries, seeking to be a part of it and incorporates it to their educational offer.

12.3.1 Wrapping-Up

The case presented confirms the relevance of thoroughly planning specialized in-company continuing education programs, and how having a precise objective definition has a leading role in guaranteeing the correct organization of topics, which final goal is to develop particular abilities in key staff. The financial group was aware that they needed the support of an academic counterpart and, on the other hand, the university recognized the importance of involving the company

Table 12.1 Enrolled participants

Country	Participants
Argentina	201
Chile	143
Colombia	421
Mexico	981
Peru	300
Total	**2,046**

in the development process, so that the contents were adequately grounded in the personnel's daily work environment. This joint effort produced a highly demanded program, by both the staff members and the human resources offices of the institution around the world.

The first generation, composed of the 2,046 participants previously mentioned, served as a program pilot. The objectives have been successfully reached and it is a meticulous result monitoring as the program evolves, that has allowed the students and company itself to feel more and more satisfied with their performance.

12.4 The NGO

12.4.1 How It All Started

Globalization and diversity are a couple of relevant, popular topics nowadays. Giving these topics proper attention, a nongovernmental organization, based in Europe, has the purpose of promoting tolerance, understanding, and a peaceful coexistence through education. Among its main initiatives, this organization has a partnership program with a dozen of internationally renowned universities, aiming to involve young, well-prepared people, as they consider them as leaders in the making.

The initiative includes, in addition to other key projects, the development of a course that addresses these issues. All the partner universities have created their own courses, at undergraduate or graduate levels. The Mexican higher education institution is an associate to this program and has also developed a particular course, different from the ones at the other participant universities: it is delivered online. While the average enrollment in the other universities was of approximately 30 students per class, when the Mexican institution launched the course in August 2010 and over 400 students registered, it was a great and pleasant surprise for the NGO. This course continues to be very successful as numbers have increased over the periods it has been offered.

12.4.2 Professional Development: Needs Identification and Audience

Realizing the potential of distance learning and being aware of the lack of deep knowledge regarding the specific subject areas the NGO promotes, among decision and policy makers, the organization reached out to the Mexican university in order to outline a training program that would help them to truly absorb the globalization and diversity concepts, and to also put them into practice to ultimately work toward worldwide peace.

In the first discussions, the nongovernmental organization made it clear that the program should be targeted to diplomats around the world, because of the nature of their work and the applicability of the courses elements. However, as the

need of globally widening access to this kind of courses becomes more evident at present, the target audience was redefined and the program will be openned to any professional who express interest in the topics.

12.4.3 The Model

The purpose of this program is to provide the participant with a consummate learning experience that will help them to not only acquire knowledge, but also to develop skills and competencies.

In order to accomplish this and, similar to the previously presented case, this program will be structured within three learning levels—basic, intermediate, and advanced—and around four main axis or topics (Table 12.2). Each level/topic intersection constitutes a module, and each module is composed of specific courses. Thus, the program will consist of 12 large sections and the courses will add up an estimate of 130 training-hours.

Before starting, the participant will take an initial survey to assess their knowledge and skills toward the courses' subject areas and, once they have finished the program, a final questionnaire will be available in order to compare their pre and postcompetencies.

Each course will include a set of key activities and resources to foster a set of abilities such as teamwork, self and global awareness, problem solving, and information analysis, among others. There will also be a final project as a requisite to successfully completing the program.

On the other hand, since this is expected to be a dynamic program, there will be several possibilities to obtain a completion diploma; for instance, it could be per course, per module, per level, per subject area, etc., yet to be defined. However, for a certificate being awarded, the entire program must be satisfactorily completed.

Table 12.2 NGO program model

Level/topic	Topic 1			Topic 2	Topic 3	Topic 4
Basic	**Module 1**	**Module 2**	**…**	**Modules**	**Modules**	**Modules**
	Course 1. 1	Course 2.1	…	Courses	Courses	Courses
	Course 1.2	Course 2.2				
	…	…				
Intermediate	**Module 1**	**Module 2**	**…**	**Modules**	**Modules**	**Modules**
	Course 1. 1	Course 2.1	…	Courses	Courses	Courses
	Course 1.2	Course 2.2				
	…	…				
Advanced	**Module 1**	**Module 2**	**…**	**Modules**	**Modules**	**Modules**
	Course 1. 1	Course 2.1	…	Courses	Courses	Courses
	Course 1.2	Course 2.2				
	…	…				

Finally, it is worth mentioning that, making the most of the intellectual resources available, the course contents will be developed by the subject area experts within the universities network.

12.4.4 To Sum Up

Although this program is in a very early stage of planning, as the proposals are still going back and forth between the nongovernmental organization and the higher education institution, and other project elements such as what platform is the most convenient or whether to have or not the support of tutors, are still on the table; this is an example of how distance education through information technologies can make a difference not only within a single organization, but across borders and around the world.

12.5 The Government Department in an African Country

The Mexican higher education institution, as part of its mission and values, aims to contribute to the solution of the country's main issues and to support the most vulnerable communities. One of the social projects that has produced gratifying results is the set-up and sustained operation of learning centers and social incubators across the nation, giving people in such communities, access to a variety of educational and entrepreneurial programs. It was during an international summit that a member of the university's senior management team presented this program to delegates from all continents, Africa included.

This is how the relationship between the university and the government department started and consolidated with their visiting Mexico for the first time in April 2011, in order to get to know the institution and its social programs better, especially the learning centers and social incubators. The delegation was formed by representatives of the African private sector, universities and, of course, members of the federal government.

12.5.1 The First Steps Toward Capacity Building

After their visit to Mexico, which included a field trip to the centers, the African commission was convinced that these were what they wanted and needed in their communities, that is, a venue to access educational resources and communication alternatives, through the use of information technologies and the opportunity to develop entrepreneurial, productive projects for sustainable development (Fig. 12.1), or what they have called in a general term: capacity building. The

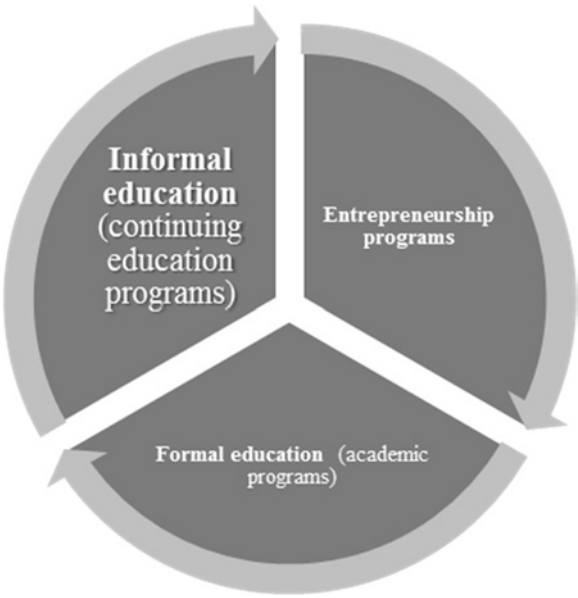

Fig. 12.1 Main components of the learning centers

project specifically aims to nurture in this African country's population the technological competencies required to internationally increase their competitiveness and favor prosperity.

But, where to start?

12.5.1.1 Collaboration with Purpose

A few months of analysis later, the government department, acting as the initiative leader, determined that it was necessary to conduct a face-to-face session, with the support of the Mexican university, in order to define objectives and expectations and design an action plan. More specifically, this two-day workshop intended to develop a general, national approach for setting up the learning centers and, since, the educational programs play a fundamental role in this task, to start the process of generating a curriculum map and the courses basic instructional design characteristics, taking into account that they should be focused on developing information technology related skills in people, particularly the stratum that doesn't necessarily have this kind of opportunities on a regular basis.

Collaborating in small groups, around 40 participants, again from the business, civil society, education, and government spheres, worked closely together to define the factors that could restrain or slow the initiative and the strategies and an action plan for the successful installation of the centers, as well as the creation of said curriculum. A thorough report of this session was developed as input for the following stages.

12.5.1.2 Working on the Curriculum

The core elements of the learning centers are the physical and technological infrastructure, the human resource and, naturally, the educational programs. Given that each partner university attached to this project will contribute with courses of their own, whether they are already developed (in whatever format) or yet to be developed, it is then imperative to have ground rules to standardize them.

Following the first workshop and after working on their own to define the next steps, the African delegation determined that one of those steps was to deepen into the curriculum map. A second 3-day workshop was planned, also with the support of the university, except that this time expert instructional designers were invited as facilitators and the audience was composed of curriculum coordinators and the people directly in charge of course development.

The purpose of these intensive sessions was to build on a series of instructional design guidelines for the learning centers' courses and, mostly, to develop instructional design skills for online content generation among the involved project leaders. Some of the topics revised were fundamentals and global trends of e-learning, course planning and development for online learning, course assembly, quality assurance, and course monitoring and evaluation.

Prior to the workshop, a diagnosis instrument was applied to assess the participants and plan how to manage the topics to be addressed; during the workshop, a practical methodology was conducted: the attendees, also organized in small groups, had to work on one of the team member's university's already existing course to apply the concepts reviewed; and finally, after the workshop, feedback from the instructors was sent via e-mail and a two-way communication among all parts was available for a good number of weeks after the face-to-face reunion.

It is worth mentioning that the participants had the chance to work as instructional designers on a real-life course, which provided them with the knowledge and abilities relevant to their responsibilities. They learned what the basic elements of a course information template are, that is, a framework used to plan and develop a course. The pieces that compose this template are, to name a few, the learning outcomes, the course outline, policy, assessment plan, the content itself, and the style guide.

Also worth mentioning is that, as pointed out above, since several universities from this African country are involved—six to be precise—and they come from diverse backgrounds and regions ranging from high socioeconomic levels to extreme poverty, the possibility of content development and competence variation, as well as different response times due to prior commitments, were foreseen. For this reason, the university and the country's project leaders have developed tight schedules for guaranteeing content delivery punctuality, instructional design guides are being generated and participative sessions conducted to ensure content standardization and uniformity.

12.5.2 The Moral of the Story

As said before, this project is also a work in progress; however, it must not be missed that, as part of a national strategy to reduce the lack of technological competencies, distance education might be a powerful instrument to close the gap between nations and to provide the possibility of equal development opportunities. This initiative is a crucial piece of a five-year plan that seeks to have an impact on ten million people in rural zones in the African country.

12.6 General Conclusions

The three presented cases illustrate the achieved synergy between a higher education institution and organizations of different nature toward capacity building. Whether it is about training collaborators in a profit-driven company; promoting, among a wide range of professionals, specific knowledge in favor of respect and tolerance around the world; or part of a national strategy to contribute to the prosperity and development of the most vulnerable communities in a country, distance education has been the solution to issues such as a disperse audience and lack of access opportunities.

We used the term *capacity building* as specific training processes for developing people, providing them with the knowledge and skills necessary for different purposes: to efficiently perform their jobs, in the case of the bank; to favor global awareness and tolerance toward cultural and religious diversity, for the ONG; and to improve their life quality, in the case of the African country.

As reviewed in these three situations, *collaboration* between the organization(s) and the school is key in every step of the way (Fig. 12.2). Whereas the higher education institution plays the role of facilitator for the required process, the organization brings in the know-how of their daily operation /topics to be covered.

The first stage of said process consisted in cooperatively identifying the specific *needs* to be met for later planning, definition and creation of the program

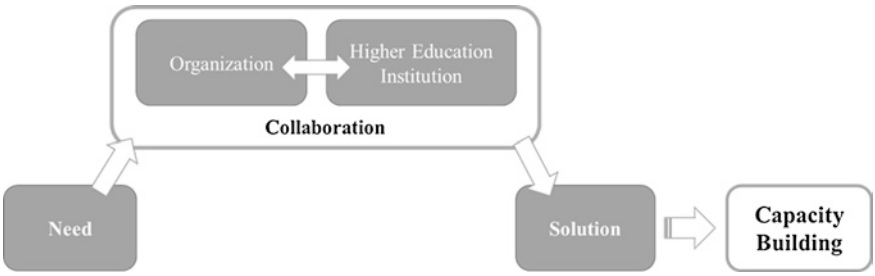

Fig. 12.2 Collaboration between institutions

with the support of content experts from the bank, the NGO and the government department respectively, and the technological and human infrastructure from the university.

The common factors for achieving people development among these were the use of information technologies, innovative training schemes, and an audience-appropriate instructional design that jointly compose customized distance education models as a *solution*, which in turn becomes the means for capacity building.

We strongly believe that this kind of joint efforts between organizations for course planning and development and the right use of information technologies, in correspondence with the participant profile, will surely have as outcome distance training programs that, in addition to being well-targeted, contribute to the participants' self-improvement, a company's growth or even a region progress.

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Marcia was a Teaching Assistant for the Industrial and Systems Engineering Department, where she served as coordinator and professor of the Production Laboratory for undergraduate students. After receiving her Master's degree, Marcia took part in collaborative projects for organizational processes optimization and worked at the Quality and Manufacture Center, in Monterrey Campus, as coordinator of the Logistics and Supply Chain extension courses and certificate programs.

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Part IV
ICT in Higher Education

Chapter 13
Innovation of Higher Education in the Globalized Era

Okhwa Lee and Yeonwook Im

Abstract Present higher education is facing the perfect storm of many game changers. There is big pressure from various stakeholders. And it is also the global era for higher education nowadays. It is the role for education to prepare students to deal with more rapid change than ever before, for jobs that have not yet been created, using technologies that have not yet been invented, to solve problems that we do not yet know will arise. It is now clear that we prepare for our next generation well for the future. In this sense, the chapter firstly presents the current trend of ICT in higher education including the new pedagogy for the digital teaching and learning, utilization of smart technology for higher education, online universities, e-learning support centers for universities, globalization of e-learning in higher education, and open educational resources (OER). Secondly, as the example of Innovation of teaching and learning in higher education, the definition, the characteristics, and the value of MOOC are thoroughly explored. Thirdly, new trend of redesigning learning space is introduced. Finally, various issues of ICT in education are discussed as a conclusion.

Keywords ICT in higher education · MOOC · Redesign learning space · Educational technology · e-learning'

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R. Huang et al. (eds.), *ICT in Education in Global Context*,
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13.1 Introduction

Present higher education is facing the perfect storm of many game changers. There are big pressure from students against the high tuition and pressure for high investment from the university administration and high unemployment rate due to job mismatch in the labor market. Statistics showed that the inflation of higher education tuition is the fastest growing inflation among any other sectors in household economy. Most of graduates leave universities with debt higher than ever, but they experience competitive job hunting, which ended only half of whom employed get jobs relevant to their major at the university.

Why does tuition keep going up? The answer comes from the social expectation and educational climate change. Universities are to the globally competitive educational market. Their performances are measured in many ways including infrastructure, quality of faculty members' research, students' performance, and reputations from the communities globally. On the result of these evaluations, high school graduates shop for higher educational institutes globally and universities need to attract students globally. Thus, it is important to keep universities competitive globally and it requires good students and high performing faculty members. Recruiting good students means big investment such as high ratio of scholarship and inviting high performing faculty members. Students and faculty members are attracted by what university can offer to them, such as good research fund, comfortable and high-end instructional environment, and generous well fare system. Nice building, good education services, and infrastructure for learning and teaching became more necessary items than ever. Without such investment, it is not easy to keep or elevate the reputation of universities. It is the global era for higher education.

While universities need more investment, ironically the public investment is getting lower. It is the phenomena that governments do not necessarily put the priority for education in budget allocation high even when they say higher education is the engine for the national growth. Public investment is getting less when the pressure for the high investment in education becomes high.

The high tuition became a social issue worldwide. Statistics show that the educational cost is the fastest growing in household expenditures. The Fig. 13.1 shows how the tuition got inflated over last 30 more years in USA. Based on the general cost inflation, the medical inflation is twice and tuition three times. It is the data from USA, but this trend is a global phenomenon (http://satyagraha.wordpress.com/2009/07/14/college-tuition-hyperinflation/).

As is well-known, medical care costs have grown faster than the general cost of living—by 2008, nearly twice as much. This receives a lot of public attention and many complaints. Yet, college tuition and fees inflated at a much faster rate: nearly three times that of general inflation (Fig. 13.1). Thus, while it took $3.30 in 2008 to buy the same general commodities purchasable for $1.00 in 1978, for college tuition and fees nearly $10 in 2008 was needed to buy what $1.00 got in 1978. This excess inflation has, incidentally, occurred across the board: for both private and public 4-year colleges and for public 2-year colleges. This is why students are being forced

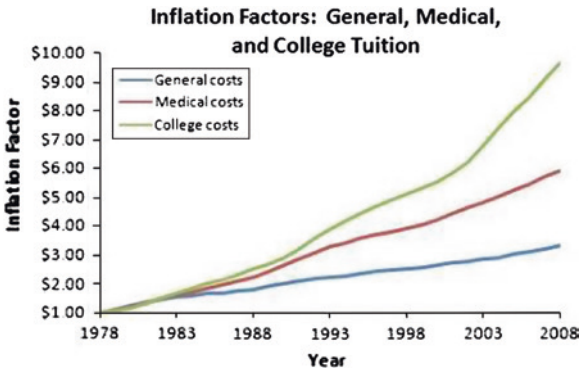

Fig. 13.1 Inflation of tuition costs. (Bureau of Labor Statistics and the College Board, 2009). http://satyagraha.wordpress.com/2009/07/14/college-tuition-hyperinflation/

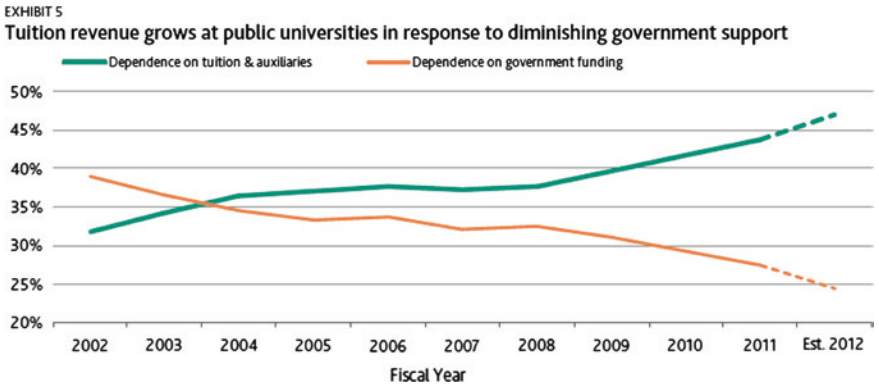

Fig. 13.2 Tuition growth and government support (The Chronicle of Higher Education, 2014)

to take out exorbitant loans. In short, after adjusting for inflation, college tuition and fees are roughly three times more expensive now than in 1978. Students' loan takes the biggest part of the household debt. It is the reason why young students demonstrated in the Wall Street in NY City and half tuition in Seoul in 2012.

This graph shows why tuition got inflated sharply. Dependence on tuition and auxiliaries had to go up when the dependence on government funding goes down (Fig. 13.2).

After graduation with the high tuition, graduates from the higher education have hard time to find a decent job. Unemployment rate for the cohort of age 20–24 is high and only half of college graduates found a full time job. One in five graduates has jobs that do not require a degree.

This high unemployment and job mismatch revels that high education institutes may not provide the key competencies for twenty-first century skills such as creativity, critical thinking, collaboration, and global perspectives, which the industries want from the new graduates.

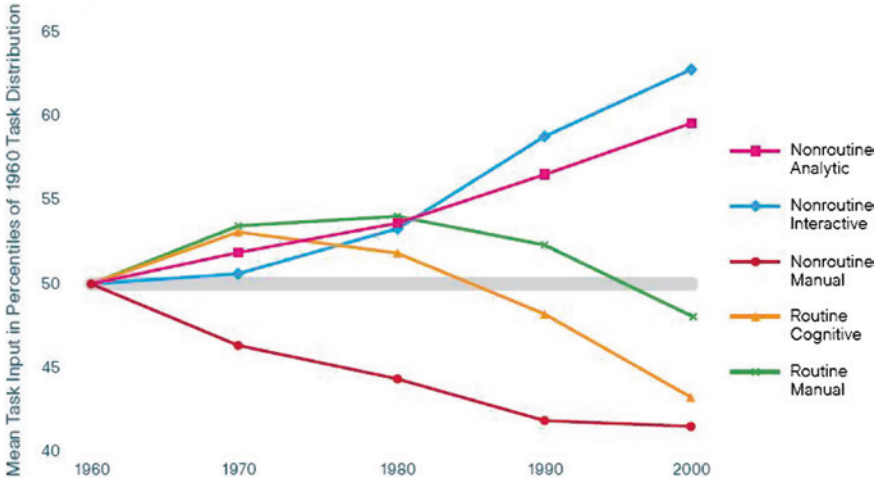

Fig. 13.3 Accelerating change demands different skills. *Source*: Recited from C. Fadel's talk at GELP in Korea 2011 May

The Fig. 13.3 shows the trends of job demands classified by routine and nonroutine jobs. The trends in routine and nonroutine task input in USA occupations: 1960–2002. The Fig. 13.3 shows that demands for the nonroutine analytic jobs such as engineers and nonroutine interactive jobs such as consultants are growing, while demands for routine manual jobs such as assembly work, routine cognitive jobs such as paper work, and nonroutine manual jobs such as pluming are decreasing. Levy and Murnane (2004) analyzed the trend that technology has cut the demand for unskilled jobs like clerks, telephone operators, and computer programmers—jobs that are governed by deductive rules and easily recognizable patterns, and are therefore amenable to automation. By contrast, it has raised the demand for high-skilled jobs—software engineers and management consultants, or jobs which cannot be replaced by technology, such as care workers. Notably, the demand is related to how routine these jobs are, not what sector they come from—many STEM jobs, for instance, are highly routine and therefore susceptible to being outsourced. Fadel (2010) argues that the dilemma of the school is that the skills that are easiest to teach and test are also the ones that are easiest to digitize, automate, and outsource.

It is the role for education to prepare students to deal with more rapid change than ever before, for jobs that have not yet been created, using technologies that have not yet been invented, to solve problems that we do not yet know will arise. It is now clear that we prepare for our next generation well for the future.

That is why the mismatch of jobs happens. Graduates from the university showed high unemployment rate. In May 2013, a study from the Georgetown University Center on Education and the Workforce opened the results on the graduates' unemployment rate as the following:

- 7.9 % not employed in 2011 USA.
- 50 % of employed has full time job.

- Difficult to find employment in their field of study.
- Half of recent grads are in jobs that do not require a degree (http://www.affordableschoolsonline.com/college-isnt-cheap/).

Then what to teach and how to learn becomes an important issue for higher education. Many researchers agree that numeracy and literacy are still important, but on top of that we need to teach more knowledge. OECD suggests for the 21C core skills and recommends the effective learning driven by the research (Schleicher 2010).

1. Makes learning central, encourages engagement, learners increasingly understand themselves as learners
2. Is acutely sensitive to the individual differences among learners including their prior knowledge; demanding for each learner but without excessive overload
3. Is highly attuned to the learners' motivations and the key role of emotions
4. Uses assessments that are consistent with its aims, with strong emphasis on formative feedback
5. Promotes horizontal connectedness across activities and subjects, in- and out-of-school
6. Is where learning is social and often collaborative.

The Nature of Learning: using research to inspire practice (OECD 2010).

Many research organizations and individual researchers agree to focus on the importance of ICT in education as the ICT links the gap between where students are now and where students should achieve. The effective learning recommended by OECD can be achieved effectively with the help of ICT. ICT expands the boundaries of formal and informal education as well as the educators and experts and learners. ICT has been a destructive innovator in industries and now it is The following chapter will discuss the current trend of ICT in higher education such as smart learning strategies in teaching and learning model, online universities, e-learning Support Centers for universities, globalization of e-learning in, and open educational resources (OER), and finally discussing the concept and meaning of MOOC in higher education.

13.2 Current Trend of ICT in Higher Education

ICT in education means incorporating Information and Communication Technology in the various educational fields. The revolutionary development of technology has affected our daily lives and the college students who are digital natives (growing up with ICT) are more than ready to use that technology very naturally. According to these phenomena, universities aggressively began to induce technology into their teaching and learning. ICT in education seemed to have provided lots of educational advantages, for example, education beyond the space and time.

Here, the current trend of ICT in higher education will be discussed as follows: smart learning strategies in teaching and learning model, and online universities.

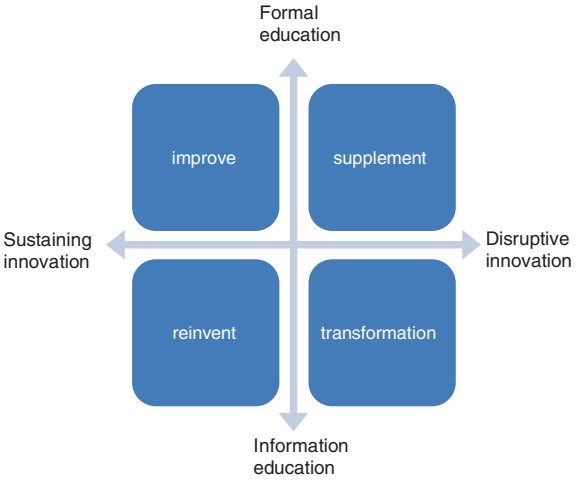

Fig. 13.4 Educational innovation grid (Leadbeater and Wong 2010)

This chapter will include the current trend of ICT in higher education such as smart learning strategies in teaching and learning model, online universities, e-learning Support Centers for universities, globalization of e-learning in, and OER.

13.2.1 New Pedagogy for the Digital Teaching and Learning

As the change of the society is fundamental, instructional method needs to adopt the call from the changes. What to teach and how to learn need to be reinvestigated. Scholars and research institutes suggest a series of skills and knowledge for the twenty-first century. The use of ICT in education can be categorized in as the following framework (Fig. 13.4). Innovation in education is for sustaining innovation and disruptive innovation. Those innovations can be practiced in the environment of formal education and/or informal education. This educational innovation grid can be used to understand how ICT in education are implemented.

13.2.2 Utilization of Smart Technology for Higher Education

By integrating educational technology into the field of higher education, universities seek for smart teaching and learning. It has possibilities to maximize educational outcome through innovative teaching and learning methodology. Students are equipped with e-learning or mobile learning devices and they study whatever they want and whenever they want through this technology. Universities support their learning with ICT-based platform and well-designed learning contents. Professors and other manpower support them by coordinating the flexible curriculum and managing learning community for the effective learning environment.

For successful e-leaning the most suitable teaching and learning model is necessary, which can induce self-motivated and self-regulated learning, creative, and

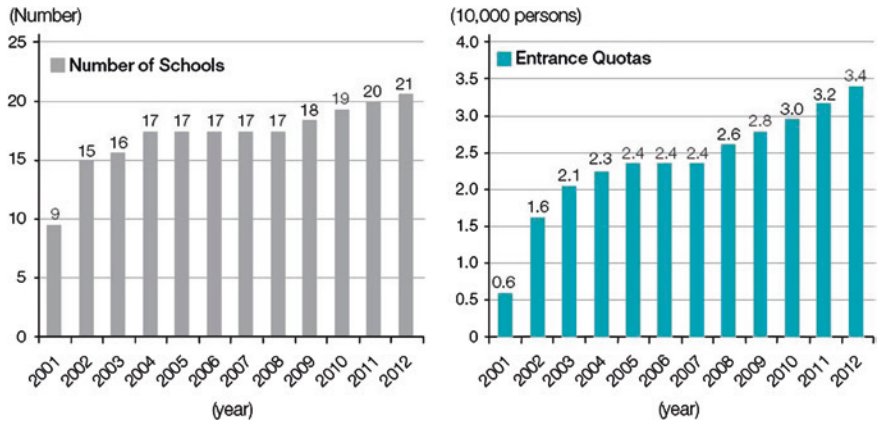

Fig. 13.5 Status of Cyber University (Ministry of Education, Science and Technology 2012)

convergent problem-solving ability, and balanced and humanistic global mind. Students should not be passive learner any more, but be active in their own knowledge construction. Learners will be put in the center of the learning process, learners' engagement and their learning agency are in focus. They will be exposed to do collaboration with peers through social network system in the world. They want the very flexible and tailored instruction, which may be possible with ICT technology. E-learning or mobile teaching system can track each individual student's learning history, analyze his or her weakness in the study and help him or her with and appropriate diagnosis and treatment. While ICT-based education handles mass students with learning contents, it cares each student at the same time. In this subchapter, cases of using ICT in higher education are introduced.

13.2.3 Online Universities

Until now, offline traditional universities have taken the role of conferring academic degrees to students in higher education. However, nowadays many online universities are established and many students have wider chances for acquiring bachelor's or even higher degrees online without having to attend classes physically. For example, Phoenix online university in the USA offers access to degree programs through online. Athabasca University in Canada is another example of providing academic degrees via online program. In Korea, there are 21 Cyber Universities, which are accredited by the Ministry of Education. As higher educational institutes, they are equipped with cutting-edge technologies in education to educate mass students. Figure 13.5 shows the Status of cyber universities focusing on the increase of their number and their entrance quotas.

Since 2009, cyber universities in Korea have started graduate programs and are taking active role in the field of higher education. These kinds of online universities are taking three main roles: providing basic higher education for mass

students, opportunities for higher degrees, and various subjects for lifelong learners who want to have different or enhancing their professional knowledge.

Korea National Open University is another good example of Korean distance learning for higher education. Recently, it opened an online program called "Prime College" for 40 or 50 years old students who want to prepare for their second life.

Compared with traditional offline universities, online universities cost less tuition, which helps students continue their study. Furthermore, it is a desirable learning environment for those students who do not have to go to school to study, especially for those who have jobs or family to care.

13.2.4 E-learning Support Centers for Universities

The Ministry of Education built 10 the University e-learning support centers in each region of Korea. The purpose of these centers' establishment is to secure e-learning infrastructure and to strengthen e-learning support in various ways (Kwak et al. 2006). They have been built from 2003 to 2007. Equipped with facilities and infra technology, these centers support ICT part in higher education. Also they support with human resources and research-based teaching and learning methodology focusing on e-learning. The status of those e-learning support centers is as follows (Table 13.1).

13.2.5 Globalization of E-learning in Higher Education

Korean Ministry of Education planned a huge project on establishing Asian Cyber University across the East-Asia area since 2009. In detail, the ACU Project is a multiyear integrated project for the establishment and the operation of a higher education institution, which facilitates the sharing of comprehensive online education services and educational knowhow between the ASEAN Member States and Republic of Korea (Lee and Im 2013).

This project tried to encompass lots of higher educational institutions for successful performance of this project. The ACU is supposed to open an online educational system for credit transfers and academic degrees. Administrative and collaborative research is needed to support the smooth progression of this project.

Currently, this project has started targeting four countries first including Cambodia, Laos, Miyama, and Vietnam. The main purpose of this project is to overcome digital divide in higher education among Asian countries and develop the human resources for global leaders.

13.2.6 Open Educational Resources

The concept of OER was introduced in 2002, when the Hewlett Foundation initiated the *Using Information Technology to Increase Access to High-Quality*

Table 13.1 The status of regional e-learning support centers

Year	Region	Regional center	No. of those contents that have been developed with government subsidy									
			'00–'004	'05	'06	'07	'08	'09	'10	'11	'12	Total
2003	Jeju	Jeju University	8	6	10	12	7	7	4	3	3	57
2004	Busan, Ulsan and Gyeongnam	Gyeongsang University	10	7	23	15	0	6	4	2	3	67
2005	Gangwon	Gangwon University	–	6	9	7	4	7	5	3	2	41
	Gwangju and Jeonnam	Jeonnam University	–	27	5	6	6	4	3	3	4	54
	Daegu and Gyeongbuk	Yeungnam University	–	8	13	15	12	11	12	6	7	77
2006	Jeonbuk	Jeonbuk University	–	–	21	16	4	3	3	2	1	49
	Chungbuk	Cheongju University	–	–	23	6	5	5	4	5	2	48
2007	Daejeon and Chungnam	Chungnam University	–	–	–	2	5	4	10	10	7	31
	Seoul	Hanyang University	–	–	–	5	2	4	3	2	1	16
	Incheon and Gyeonggi	Inha University	–	–	–	5	4	4	5	4	2	22
Total			18	54	104	89	49	55	53	40	32	494

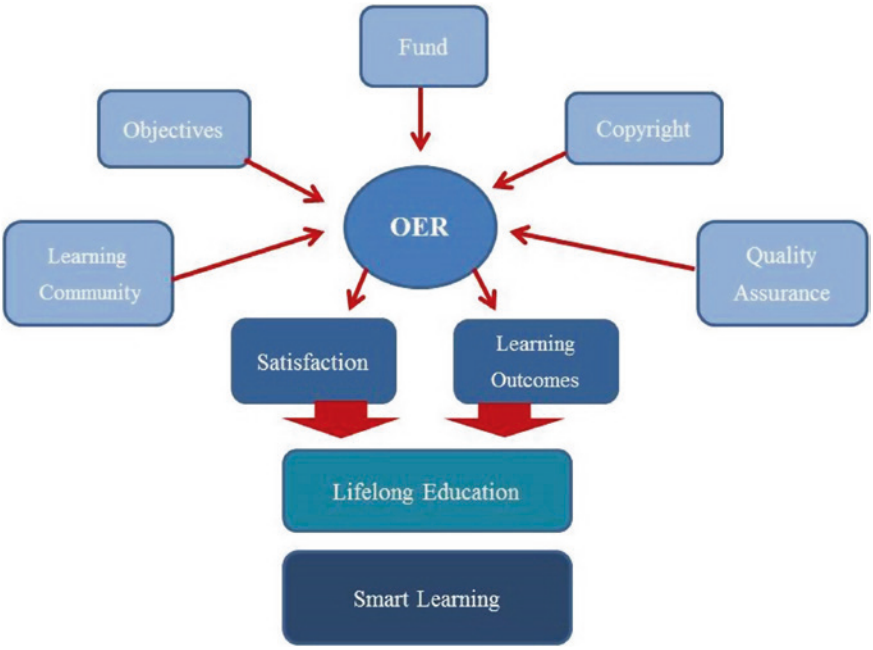

Fig. 13.6 OER usage model in higher education (Leena et al. 2012)

Educational Content education program (Atkins et al. 2007). Although OER are high on the agenda of social and inclusion policies, and supported by many stakeholders of the educational sphere, their use in higher education has not yet reached the critical threshold (Vainio et al. 2012). The importance of OER does not lie on the accessibility to the digital content simply, but on the educational efficiency, effectiveness, quality, and strategies in teaching and learning.

Such forerunners of OER as Massachusetts Institute of Technology (MIT) in the USA (Bonk 2009) or other leading universities are now playing an important role in the OER area. The professors act as an educational coordinators or facilitators along with knowledge deliverers. OER can be customized, and modified to meet the individual learner's situation. Well-contrived learning community with OER can also promote students' cooperation and collaboration for the social learning.

In the mechanism (Fig. 13.6), such input factors as objectives, fund, and copyright issues should be considered first. Next in the process phase, the effort for quality assurance and provision of the learning community environment is important. Such outcomes as learners' satisfaction and achievement are led to lifelong education and smart learning (Vainio et al. 2012).

Recently, the issue of OER in higher educational settings is closely related with the issue of MOOC. Especially not a few universities in the world are trying to introduce the new trend, MOOC. In the next chapter, we will discuss about the issues of MOOC in the field of higher education.

13.3 Innovation of Teaching and Learning: Mooc

Innovation of teaching and learning in higher education is heavily influenced by ICT use as many other sectors in the society are. Technology and social pressure for the low tuition are the two main forces for the innovation in higher education. Technology development provided OER, and more recently, Massive Open Online Courseware (MOOC) to higher education and they have been the major drives for educational innovations. MOOC is rather a new technology, while OER has relatively long history. OER in higher education offered the big impact on contents creation and instruction, but with the emergence of MOOC, higher education need to go through transformative innovation, to rethink the roles of the universities, particularly for the role of knowledge delivery, which is one of the three main functions of universities: teaching, research, and service. Due to the profound potential impact of MOOC in higher education, most of media introduced MOOC as the agent for the paradigm shift of higher education in 2012 and still now. New York Times 2012 has an article about "The Year of the MOOC" (http://www.nytimes.com/2012/11/04/education/edlife/massive-open-online-courses-are-multiplying-at-a-rapid-pace.html?pagewanted=all&_r=0).

In this chapter, characteristics of MOOC and details of present practices of MOOC are introduced. This can show how innovating contents, pedagogy, learning methods, and assessment in higher education are being implemented in higher education.

13.3.1 What Is MOOC?

13.3.1.1 MOOC Is a Real Classroom Activity

MOOC is an educational platform where online contents and instructional activities are available. MOOC is the university building where professors can conduct their classes, thus contents for courses are accessible and students can interact with peers and teachers. Those existing OER contents by itself are not MOOC as they do not have instructional activities, thus those contents do not require classroom interactions. MOOC is not only contents, neither platform which has no contents in it. MOOC means learning environment where contents and instructional activities do exist. Therefore, MOOC consists of two major elements: contents (often in video format) and instructional activities (feedback, tasks, and evaluation). The platform can be used for many classes. One MOOC can have classes from many universities. MOOC classes can come from many participating universities of the world. MOOC received high attention due to the fact that world leading universities like Harvard, which was not active in online learning, decided to participate to create MOOC with MIT.

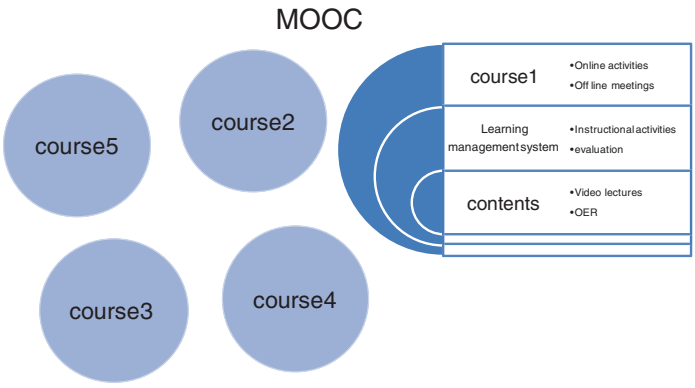

Fig. 13.7 Elements for one MOOC course

13.3.1.2 MOOC Is Free

Courses from many renowned universities are offered through MOOC free. Individuals can have the access to those MOOC courses free, but participating universities pay membership fee to use the platform. As long as students have fast internet connection enough to receive video lectures without interruption, the MOOC is open to the public (Fig. 13.7).

13.3.1.3 MOOC Classes Are Massive

MOOC class in general does not limit the number of students due to its class size not like most of physical classes or other online courses. An access to MOOC classes is open to students from over the world without any barriers. A few thousands of students take MOOC classes and it is not surprising to see more than 100,000 students take a same course together. MOOC instructors can teach more students through one MOOC class than the number of students from the campus-based classes that the instructor can teach in his/her lifetime.

13.3.1.4 MOOC Offers Strong Learning Community

The massive number of students from all over the world can keep the learning communities 7/24. Since students come from all different time zone, the learning community can be alive 24 h and there are usually a few people who can provide feedback to other students' requests. Interaction includes feedback on contents as well as their homework, group work, evaluation for the peer groups, and teachers. Students make small study groups for specific needs such as interests online as well as offline by location.

13.3.2 Educational Value of MOOC

Ministry of education in USA conducted a meta-study for online learning effectiveness and found some of key findings of research-based use of e-learning in 2010 (http://www2.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf).

- Blended learning had a larger advantage to face or online only learning.
- Students with collaborative or instructor-directed learning were better performed than those learners who worked independently
- Effectiveness of online learning approaches different domains and learner types.
- For group online learning, support (guiding questions) influence the way students interact, not the amount of what they learn.
- Online learning has positive effects in relation to undergraduate and older learners.

13.3.2.1 Just in Time Learning

Since MOOC has massive participants, the question is usually responded by someone in the learning community space. Just in time learning is possible as MOOC is massive and online. It is proven that Cousera co-founder Dr. Koller reports that the immediate response time is 22 min. It is surprisingly short response time, which is not normally possible in campus based classes (http://www.ted.com/talks/daphne_koller_what_we_re_learning_from_online_education.html).

13.3.2.2 Data For Study on Human Learning

The massive data from MOOC students' learning within the context can show how people learn. Since it is the data from many students and most of instructional activities, the data can show how students interact with other students, when they use different kinds of contents media. From the learning analytics of edX data reported in 2013 June from the learning of 2012 March first edX course data (http://www.rpajournal.com/dev/wp-content/uploads/2013/05/SF2.pdf) reported that MOOC students use Q&A BBS and lecture video for homework and group tasks, but use text loaded for the midterm and final examination.

13.3.2.3 Individualized Tutoring

Benjamin Bloom in 1984 proposed that individualized tutoring can enhance students' performance at two sigma power. He examined three different learning groups toward the mastery level (lecture-based classroom, lecture-based classroom with mastery learning, individual tutoring) and compared the effectiveness of learning by instructional types. The mastery-based learning group was a full standard

deviation, or sigma, in achievement scores better than the standard lecture-based class, and the individual tutoring group showed two sigma improvement in performance. It means that the median performance of lecture-based class as a threshold means that the half the students of the lecture-based classroom are above that level and half are below. In the individual tutoring instruction, 98 % of the students are above that threshold. It is the premise that MOOC technology can provide individual tutoring learning experience to students as close as possible (http://www.ted.com/talks/daphne_koller_what_we_re_learning_from_online_education.html).

13.3.2.4 Student Active Learning

MOOC use is for online learning students who take MOOC courses for their own learning experience without attachments with credits, institutional certificates or degrees. It means MOOC students are motivated learners with self-regulatory skills. When MOOC classes were used in campus-based universities, often times flipped instruction is employed so that students study the contents of MOOC at home on their own time and in the classroom, active interactions with instructors and students such as discussion, group projects, and problem solving, which requires high level of feedback and interaction are occurred. The flipped instruction offers opportunities to use student-centered instructional strategies.

13.3.3 Examples of MOOC

MOOC classes are offered through a few major MOOC platforms. Here two major ones are introduced: Coursera and edX.

13.3.3.1 Coursera (**http://www.coursera.org**)

Type of Organization: For Profit Organization

This company founded in 2011 fall from the experience of first MOOC course in Stanford. “Coursera is an educational company that has partners with the top universities and organizations in the world to offer courses online for anyone who wants to take them, for free” (https://www.coursera.org/about). It is the biggest MOOC platform so far and grows very fast: 17 million enrollments (5 million Courserians) from 190 countries (Fig. 13.8).

The business model evolves fast that they offer various types of business models. Signature track courses are available at 100$. Offering certificate program requires fee and coursera made one million dollars for this in 2012. It shows how massive students enroll in MOOC.

Fig. 13.8 Example of certificate from Coursera

- Courses: 453 courses from 88 partners as of Sept. 2013.

Courses offered in seven languages with subtitles in 12 languages. The number of courses offered through Coursera is growing fast.

- Pedagogy: Coursera emphasizes on their pedagogy research-based pedagogy: research proven efficacy of online learning pedagogy, activities to retrieve or reconstruct knowledge, mastery learning to produce significant gain in learning, peer assessments to reduce instructor efforts and learning gains, and pedagogies for active learning in the classroom.

13.3.3.2 edX (http://www.edx.org)

Type of Organization: Non for Profit Organization

edX was founded in 2012 with MIT and Harvard to offer their courses fully online at free of charge. MIT has been one of the main leaders for online learning by initiating OER called open courseware (OCW), which was translated in many languages, now expanded to MITx with video courses. On contrary, Harvard has been conservative in online learning for their courses, but with the new movement with

MIT, Harvard and MIT made the MOOC as the keyword in 2012. Since edX was launched, many other institutions approached edX to join the platform.

- Courses: As of 30 Sept. 2013, the number of courses offered is 72, but the number is growing fast. Universities from the world are joining and the speed toward this movement is fast too.
- Tuition: It is free to individuals, but institutes can join edX with 3,000 dollars membership fee. It has been the policy that edX offers their courses free to individuals, but in September, edX announced that people who followed sequence of courses prescribed by MIT can receive special certificate with fee. The sequences will be called XSeries (http://chronicle.com/blogs/wiredcampus/mit-will-offer-mooc-curricula-not-just-single-courses-on-edx/46715) and the first XSeries will be the computer science series, which will start from 2013 fall. It requires six series of courses and can cost 700$. Universities offering courses at edX may charge 50–100$ for certificate or official badge. The vision of edX is to offer quality education to all, but it will also take revenue-driven policy to keep its sustainability.

13.3.4 What We Have Learned from MOOC?

Through the analysis of MOOC data, some of the learning styles were proven. The following is what we have learned from the MOOC experience (Breslow et al. 2013, second reference from Kurzweil 2013). The results are in the following.

13.3.4.1 10 % of Participants Finish a Course Successfully

Big number of student participation in MOOC classes, but on average only 10 % of them finished the class and 5 % received certificates successfully. MOOC classes do not have constrains to accept the class enrollment, which includes any class enrollments who wants to taste the class or anyone who browse MOOC classes. Two thirds of students registered, but never returned to the class. Among those who submitted the second home works, 40 % of students continued to earn a certificate.

13.3.4.2 MOOC Students' Level Is High

Since MOOC draws massive number of students, people assume the quality of MOOC students is not high. But one of the first MOOC, "machine learning" from Stanford university, showed that the best student from the Stanford class was 140th in the MOOC class. MOOC classes are often enrolled by experienced workforce to keep up their knowledge.

13.3.4.3 Only 3 % of Students Participated in Discussion Forum

Among the registered students, only 3 % participated in discussion forum. Students are rather passive users of discussion forum: "90% of the click activities came from users who viewed existing threads without posting comments". Certificate earners used the forum at much higher rate than other students: 27.7 % asked a question, 40.6 % answered a question, and 36 % made a comment. 52 % of the certificate earners were active on the forum.

13.3.4.4 Students with Collaboration Offline Earned Better Scores

Students reported working with other students offline tended to score higher than student working alone. (http://www.kurzweilai.net/online-learning-at-stanford-goes-open-source-with-openedx) It seems natural that those students who had offline meeting for the MOOC class are active learners so that active learners perform better.

13.3.4.5 Video Materials for Homework, Text Documents for Tests

According to the learning analytics of edX, (http://www.rpajournal.com/dev/wp-content/uploads/2013/05/SF2.pdf, students used discussion board and video for homework and online textbook for tests. This means that both students from online classes and campus-based classes use text (online documentation) for exam.

13.3.4.6 Characteristics of Successful MOOC Learners

Curtis (2013b) reported the characteristics of successful MOOC learners as the following:

- Self-motivated
- Good at self-directed learning
- Shares their creation
- Delights in wider range of info resources
- Takes pride in learning on their own

(http://www.trainingshare.com/pdfs/MOOC_Research_Blackboard_MIT_ICE-Japan.pdf).

13.3.5 Business Model for MOOC

MOOC is offered free but developing and maintaining MOOC require resource. At the beginning of MOOC, universities receive support from various sources, but it

is necessary to find business models, which can make MOOC sustainable. Curtis (2013a) classified business models for MOOC as the following:

- Advertisers underwrite courses and degrees
- Small and flexible application or enrollment fee
- Course assessment fee
- Certificate fee
- Enhanced course fee and option for university credit (full price)
- Percent of first year salary: Udacity receives incentives from the company (Google), which recruits students from MOOC course for 20 % of their first year salary.
- Sell or lease courses (to other colleges)
- charge fee for student data

(http://www.trainingshare.com/pdfs/MOOC_Leadership-Principles_World_is_Open.pdf).

One of potential source for the business model is the certificate. The Fig. 13.13 shows an example from Coursera course. Figure 13.13 Example of certificate from Coursera course at 39$ in 2012 spring.

13.4 Learning Space Redesign

Higher education with ICT can be enhanced with properly designed physical support to put students in the center. Learning space, classroom redesign, is to support pedagogies of collaboration, active learning environment, students' engagement, and flipped instruction. In this section, some of the classroom redesigns for the innovation for the university are introduced.

13.4.1 TEAL at MIT

The physical lab MIT made as a physics lab was called TEAL (Technology-enabled active learning). The room is designed to offer projectors to each group table and the teacher is located in the center. This design emphasized group collaboration work. TEAL is designed for collaboration so that each table has a projector and a computer. Each table is designed to do collaboration work so that projectors are provided with computers and can be shared among the whole group in the class (http://www.educause.edu/ero/article/learning-space-design-action).

This class is designed to do collaborative learning in a small group to share their processes and data to the class using laptop computers and projectors. The TEAL physics Lab was motivated by the fact that the class had low attendance rates (at MIT, attendance rates were frequently 40 % to 50 %) and to prevent high failure rate (averaging 10 % or greater). The course design is based on

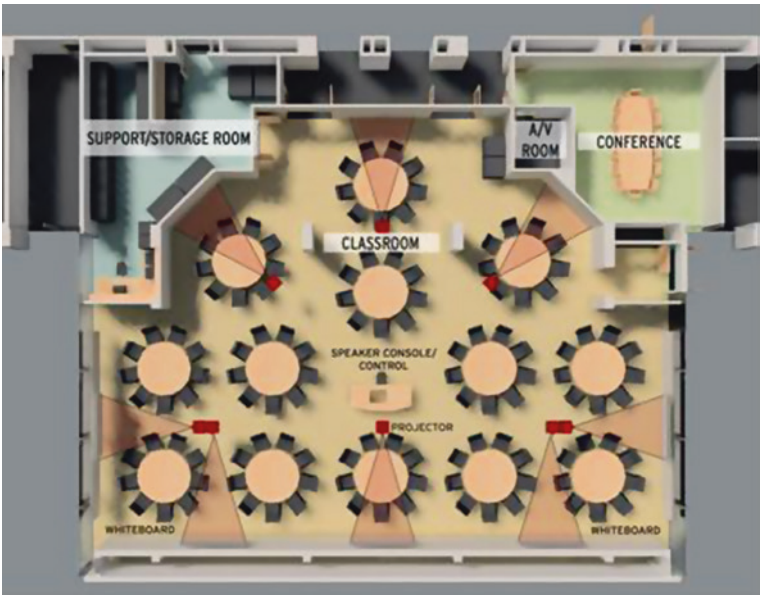

Fig. 13.9 MIT TEAL class design (Phillip D. Long 2005)

the belief that interaction among students and instructors can promote learning (http://www.educause.edu/ero/article/learning-space-design-action) (Fig. 13.9).

13.4.2 CITL at New York University

The learning innovation at New York University is led by the Center for Innovation in Teaching and Learning. It is the teaching and learning center, which supports faculty and academic groups, to enrich courses and programs through the use of technology. The center leads pedagogical innovation by supporting faculty members with seminar and workshops. Their classrooms are equipped for group work and authentic to the real world. It is noticeable to see classrooms are nicely equipped with educational technology and conventional environment. (http://www.stern.nyu.edu/citl) (Fig. 13.10).

13.4.3 Course Redesign at University of Maryland

The initiative started and lasted in 2006–2009. The roadmap for redesign was set. This program demonstrated how college and universities can redesign their instructional approaches using technology to achieve cost savings as well as quality

Fig. 13.10 MIT TEAL class room facilities (http://icampus.mit.edu/projects/teal/) (Coursera, 2014)

enhancements. The course redesign is to solve problems of large enrollment for quality education at low cost because those classes can make visible impact of course redesign (http://www.usmd.edu/usm/academicaffairs/courseredesign).

University of Maryland adopted the research Carnegie Course Redesign Initiative, **and** have adopted techniques to redesign courses based on principles by the National Center for Academic Transformation (NCAT—http://www.thencat.org).

Principles for successful course redesigns by NCAT are

- Whole course redesign.
- Active learning.
- Computer-based learning resources.
- Mastery learning.
- On-demand help.
- Alternative staffing.

(http://www.provost.umd.edu/USM-CR2-information.pdf).

13.4.4 Math Lab at Emporium at Virginia Tech

Learning Center for studying Mathematics led this massive scale computer lab. In the big room which was a shopping mall before the Virginia Tech bought for (Fig. 13.11).

Fig. 13.11 Emporium math lab at Virginia tech (2014)

There are about 537 apple computer work stations in the big room. The room has a large meeting area equipped with a computer projection system and interaction in a group setting. Help room tutors can be possible by putting the red color cup on top of the computer. Small meeting rooms are available and space for relaxation is also available.

Center for Instructional Development and Educational Research (CIDER) leads this program. Software for cyber lab and contents for flipped instruction as well as self-practice, space for group work are also designed. Feedback at the lab is delivered quickly by using the red paper cup. It is done by simple technique, but efficient to operate the big emporium lab. Many students come to use this lab.

13.4.5 KALS at University of Tokyo

Komaba Active Learning Studio leads the classroom redesign. In the classroom, movable furniture was installed to rearrange the room easily upon the instructional needs such as the table shaped bean for group working. The room is designed to attract instructor's help immediately and instant display for results, student's level of understanding (Fig. 13.12, Table 13.2).

Fig. 13.12 Student centered learning lab at the University of Tokyo (KALS, 2007)

Table 13.2 Characteristics of KALS

Design concept	KALS was created based on the University of Tokyo's goal of and ideal liberal education. The KALS facility and ICT devices are specially designed to reflect each student's contribution immediately
Layout	The studio capacity is 40 people. The layout of it is similar to that of TEAL. The bean shaped tables to create group workstations seated with two to six people in various combinations
Equipment	Tablet PCs, interactive digital white board, the personal response system, PRS, a four-sided array of wireless projectors
Courses	Life sciences, history of sciences and technology, english academic writing and so on
Types of teaching and learning	Lectures, discussion, group work, presentations

13.4.6 Education 3.0 Class at KAIST in Korea

The Education 3.0 at Korea Advanced Institute of Science and Technology (KAIST) is the brand for educational innovation. The goal is to provide student centered, synthesizing, and two way feedback. This KAIST model is based on flipped instruction and collaboration activities in the classroom, which requires one projector and one screen per table (Fig. 13.13).

The process of Education 3.0 is flipped instruction:

- no formal lectures during the class,
- pre-recorded lectures,

Fig. 13.13 Education 3.0 class model (KAIST, 2008)

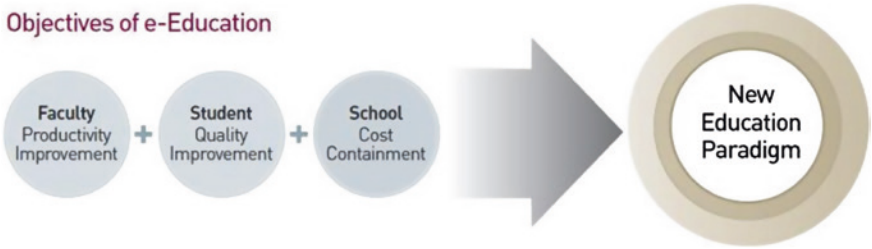

Fig. 13.14 e-education at UNIST, Korea (UNIST, 2011)

- reference materials via Internet,
- performing simple experiments,
- communicate with Professors in other countries through the Internet and Skype,
- consult with the local KAIST faculty.

The feedback and effect of Education 3.0 is high satisfaction level investigated by self-survey feedback, but the cost for classroom development was high.

13.4.7 E-education at UNIST in Korea

As in e-commerce, technology became the engine for disruptive innovation, technology in education can become the disruptive innovation, so it is called e-education as commerce with technology is called e-commerce (Fig. 13.14).

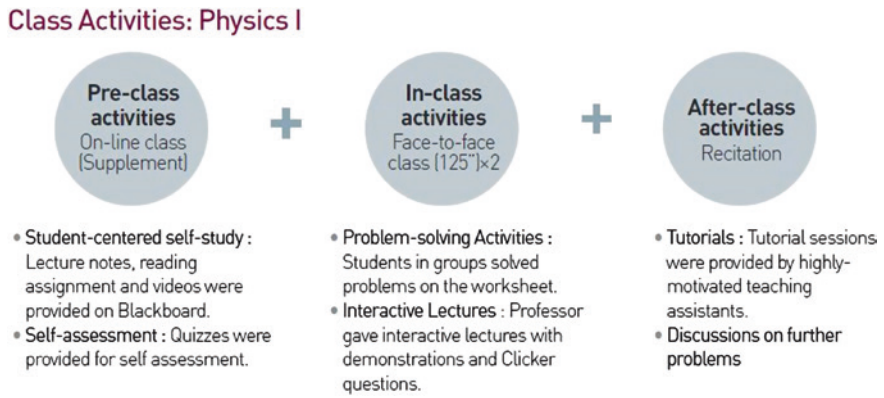

Fig. 13.15 Class activities: flipped instruction of physics (UNIST, 2011)

The e-education 3.0 is possible with the established infrastructure and course redesign. The course is based on flipped instruction model, which consist of three stages: pre-class, in-class, and after-class. Figure 13.12 shows a course redesign for a physics class using flipped instruction (Fig. 13.15).

13.5 Conclusion: Issues of ICT in Education

In this chapter, the most recent trend of higher education including MOOC was discussed. ICT in higher education experience is in need more than before to solve problems of social pressure. Globalization of higher education and aggressive movement of OER are significant characteristics of current ICT in higher education. Particularly, MOOC is of worldwide interest and this chapter has dealt this issue in detail.

MOOC will be certainly an important influence to higher education innovation unless MOOC shows its application for the mainstream campus-based education, the impact of MOOC will not be as big as expected. According to the survey done by BlackBorad MOOC, goals and motivations for MOOC participation are to improve their job prospects, to pursue personal interests or hobbies, seeking certification of some type, information seeking, means to expand one's formal learning. The MOOC may not be as disruptive as some had imagined if the market for MOOC stay to have the same business model. But the rapid rise of online "certificates" becomes a new trend and these certificates programs threaten traditional university degree programs. MIT will offer MOOC curricula and San Jose State University of California and University of Virginia Tech also take Coursera programs for their degree program.

This chapter pondered on the task most universities face in the world nowadays, and explored the solution for that by introducing ICT strategies in higher education. In the future, it is significantly inevitable to find how to use educational

technology in order to obtain efficient and effective higher education. Thus, the current situation of ICT in higher education is presented, and how to improve the quality of higher education incorporating ICT is discussed.

Technology is not just technology: it is a vehicle to open the innovation at higher education. Somewhat unlimited potential of ICT may open a very intriguing and splendid world in the field of education. As students are ready for this already, manpower in universities should be ready enough to suggest pedagogical excellence to them. Well-designed teaching and learning strategies with ICT support will ensure the quality of the higher education. Especially MOOC, the cutting-edge innovation of teaching and learning for higher education would be an important keyword for the future ICT in higher education.

Acknowledgments If you wish to acknowledge persons who contributed or sponsoring agencies, do so here in this optional section.

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She has been the pioneer of educational movement for computer education, e-learning, smart education in Korea since the concept of ICT application in Korea was introduced at the national level in 1987. Her interest has been educational innovation with technology support since she finished her academic training at the University of Wisconsin–Madison in USA for the master’s and Ph.D. program. She has served on three President’s committees (Republic of Korea)—the President’s Council on Information Strategies; the e-Government committee of the Local Government Innovation Council; and the committee for educational reform. She received the national medal for her service in the development of e-Government in 2007. She has been involved in the report for Korean education 2030 when she served at the committee for educational reform. The smart education strategy is one of the policies she participated in planning 2009 as a member of the Presidential committee.

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Her research interests are e-learning, distance education, instructional design, blended learning, e-learning quality assurance, and mobile learning.

She achieved her bachelor's degree at Seoul National University, master's degree at Harvard University and doctoral degree at the University of Pittsburgh in the field of Educational Technology.

Chapter 14
The Framework for e-Learning 2.5 and Its Primary Functions

Through the Organizational Knowledge Circulated Management on e-Learning

Toshio Okamoto, Fumihiko Anma and Naomi Nagata

14.1 Introduction

Shifting to a knowledge-based society, high-level educational environment, in which it is possible to continue to learn for not only full-time students but also working students, is needed in higher education. It is e-Learning to realize such kind of educational environment because distributed students can learn collaboratively with multimedia contents anytime and anywhere by e-Learning technology. At the same time, technologies on the Internet have rapidly developed and changed to the direction of social computing to emphasize social interactivity like WiKis, Bookmarking, Blogs, Add-ins, Mash-ups, etc. By this change, the concept of e-Learning shifts from individual learning supports to group, organization, community, and society learning. The features on this shift are bottom-up, learners-driven, peer learning, and knowledge sharing oriented. The method of content access has provided various kind of search engines, RSS feed, and so on. For example, Web Page is not only to read, but also to rewrite/add-in, share/reuse, and co-build/create fresh knowledge.

In consideration of these changes/shift of Internet technologies, our practical purpose is to convince our faculty of e-Learning worth by giving experiences with online education. Methods to support faculty for online education are:

(1) Organizational collaboration;
(2) Facilities: e-Learning studio, e-Learning room, LMS;
(3) Developing system: authoring system, monitoring /mentoring system, supporting system for building Learning Community, evaluating system, etc.;
(4) Faculty development: method of instructional design and learning design.

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R. Huang et al. (eds.), *ICT in Education in Global Context*,
Lecture Notes in Educational Technology, DOI: 10.1007/978-3-662-43927-2_14

Nowadays, the concept of WEB2.0 has been proposed by many researchers and developers who are interested in Internet technologies and new business, the social computing/networking, Cloud/Grid computing, etc. In this stream, the new concept of e-Learning begins to be discussed among e-Learning researchers, educational technologists, companies, and so on. Especially, the words of "collaborating and social networking," "recommendation and community formation of learning," "sharing and reusing," etc. seem to be very useful to realize and build the concept /e-environment /technology for "e-Learning 2.0."

14.2 Research Background

14.2.1 Organizational Collaboration

Our university established the center for developing e-Learning (CDEL) to promote the GP project. As shown in Fig. 14.1, we have constructed organizational collaboration for e-Learning in our university. The center for research and developing e-Learning plays a central role in improving educational activities. We have developed the multifunctional LMS(WebClass-RAPSODY) for supporting to make the plans and develop contents, promote faculty developing, manage copy rights, conduct mentoring and coaching, etc.

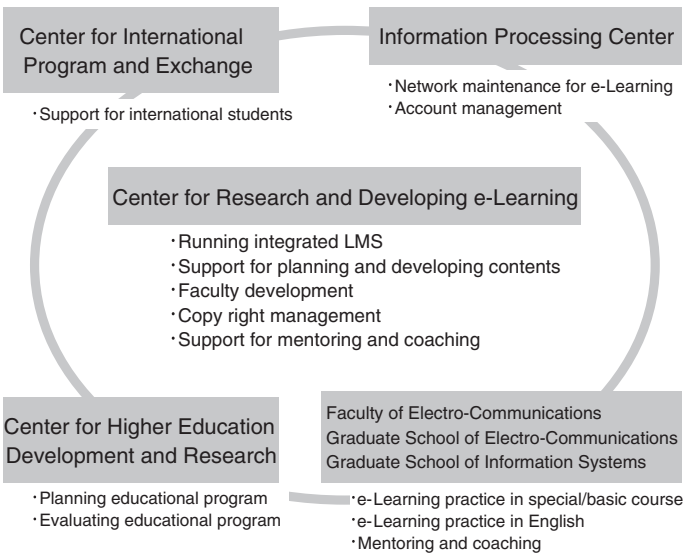

Fig. 14.1 Organizational collaboration in UEC

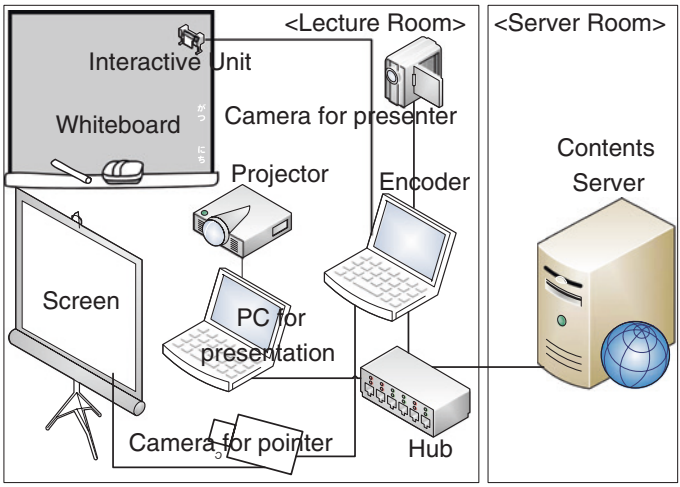

Fig. 14.2 Authoring tools in lecture room

14.2.2 Facilities

The center for developing e-Learning (CDEL) has an e- Learning room, e-Learning studio, and an intelligent LMS (Webclass-RAPSODY). It is possible to use e-Learning studio for the faculty in order to make educational movies with their presentation documents on PC and their handwritten manuscripts on a board. Furthermore, these authoring tools can be used in usual lecture rooms as shown in Fig. 14.2.

14.3 Organizational Knowledge Circulated Management

14.3.1 Mission of CDEL

The services and researches provided by the center for developing e-Learning (CDEL) are as follows.

A: Service

- Rent e-Learning room, e-Learning studio, authoring system,
- consult faculty about e-Learning,
- management of contents' copy rights,
- open seminars, forums, international conferences.

B: Research

- Develop/storage/reuse contents/tools/application for learning,
- educational/technological research with international collaborations,
- standardization in e-Learning (ISO/IEC-JTC1 SC36),
- educational improvement by ICT.

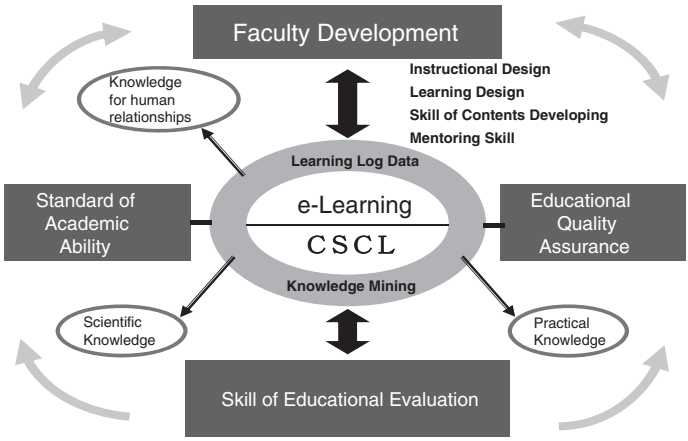

Fig. 14.3 Mission of CDEL

These services and researches are based on the missions of CDEL shown in Fig. 14.3. By using learning log data of CSCL in intelligent LMS, CDEL can standardize academic ability and assure educational quality by skill of educational evaluation. Then CDEL contributes faculty development with topics such as instructional design, learning design, content developing skills, and mentoring skills. In the opposite direction, the higher faculty's ability is, the higher the standard of academic ability and educational quality assurance our university is. In this paper, we introduce our new promoting activities based on these missions of CDEL: one is developed mentoring system for supporting faculty from technological aspect and the other is developed methodology for instructional design and learning design from pedagogical aspect.

14.3.2 Knowledge Circulated Management System

Based on technological and pedagogical aspects, we try to construct knowledge circulated management system shown in Fig. 14.4. In the current stage, a system for the process which extracts frame-construction and frame-sequence is developing and instructors are needed to extract them by charts.

14.4 Mentoring System and Its Architecture

It is difficult to sustain e-Learning activities. Thus, regular mentoring for learners is important to keep their motivation to learn. However, it costs too much time and jobs for lecturers to give all learners' advice constantly, thus it is needed to automate mentoring activity. From the technological aspect, we have developed the auto-mentoring system first. Our definition of "auto-mentoring system for

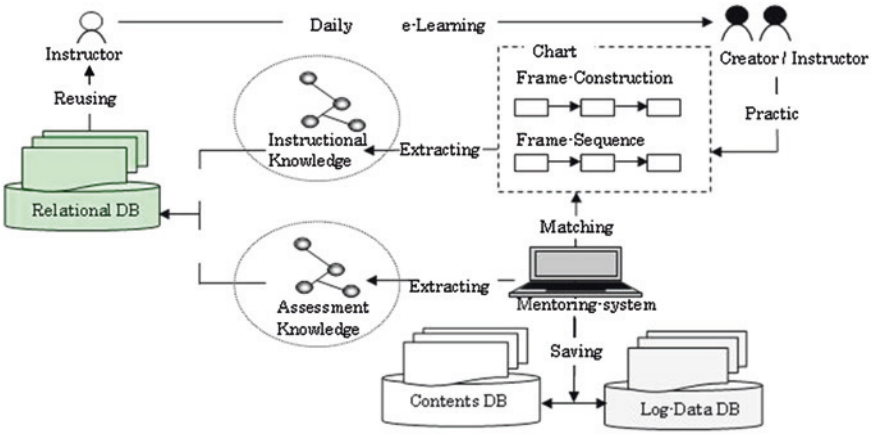

Fig. 14.4 Knowledge circulated management system

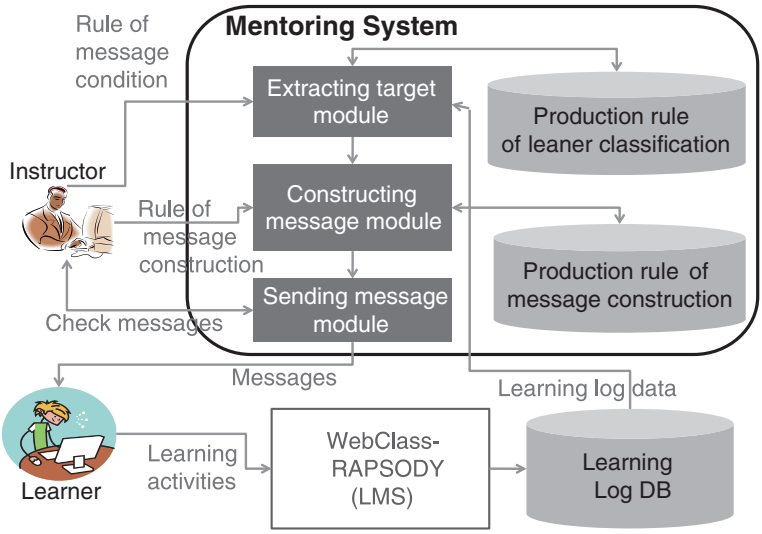

Fig. 14.5 Architecture of mentoring system

supporting lecturers" is a system in which it is possible to extract targets by learning log data from LMS and send mentoring messages automatically.

The first version of our mentoring system supports learners to keep learning activities in one course. This first version is explained in this paper but we have a view of the next version which supports learners to finish all courses with its answering their questions or pointing out their weak points as well. The outline of the first version of mentoring system is shown in Fig. 14.5.

An instructor makes rules of learner classification and message construction at first. These rules are records of production rule of learner classification and

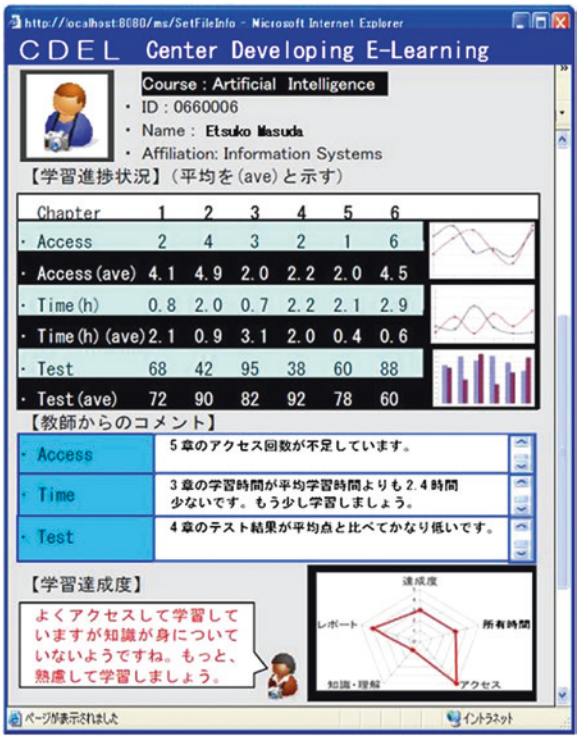

Fig. 14.6 Example of e-Karte

production rule of message construction each. Extracting target module matches learning log data with production rules of learner classification and extracts target learners who need mentoring messages. Then, sending message module makes appropriate messages for target learners and asks the instructor to check them. In the case that the instructor allows mentoring system to send messages to target learners, sending message module sends them to target learners. Learning activities of each learner records in learning log database through WebClass-RAPSODY, that is our LMS. An example of e-Karte learners get through this process is shown in Fig. 14.6.

14.5 Present Technological Functions on e-Learning

Our organizational knowledge circulated management system heads for preparedness of the below five functions, in order to realize new information technology systems of e-Learning.

(1) *Authoring function*: Information technology and methodology for developing high-quality contents.
(2) *Supervising function*: Management and statistics/evaluation functions of learning objects and learner's information including learning log data.

(3) *Learning support function*: Diagnosing, mentoring, and evaluating through learning process.
(4) *Collaborative and active learning/working function*: Indicator of request/referring information. Mail and chat. Collaborative learning/working field. Knowledge hunting.
(5) *Knowledge mining/reusing management function*: Data/knowledge mining. Knowledge sharing/reusing. Knowledge systematizing.

In addition, there are nine aspects to evaluate the organizational knowledge circulated management system. They must be used in the case when integrating a huge system like ours into a whole university.

(1) On top access to information
(2) Security
(3) Stock/circulation of know-how and technology for developing/improving contents
(4) Learning objects and repository
(5) Assessment technology
(6) Logical integration between academic affair information and learner's information, such as profile, curriculum, syllabus, registration status, record, mentoring, guidance, and so on.
(7) Linkage of faculty development
(8) Linkage of pedagogical activity without e-Learning
(9) Cost and performance.

The organizational activities of e-Learning practice in this model are related to faculty development, which is an important mission of CDEL. Our mentoring system and methodology of Instructional Design and Learning Design support faculty to do its activities in Context, Content and Personalization, especially from the side of Behavior and Usage analysis. In addition, mentoring system has already set in Infrastructure.

Although our job in the side of Community is still in progress using the concept of social computing, unfortunately, we will complete organizational collaborative management in e-Learning with this model.

14.6 Participatory Learning Environment Based on Social Networking Services

SNS is classified into the service of Web 2.0 that is proposed by O 'Reilly (2004). In the service classified into Web2.0, the value of the service rises by obtaining the contribution of the user. Consequently, it often leads to the development of the service. Therefore, obtaining the contribution of the user becomes an important factor, so that service may grow up. O 'Reilly defined the environment designed aiming to obtain the contribution of the user like Web 2.0, "Architecture of Participation."

In this paper, we pay attention to this "Architecture of Participation." For this, we introduce an SNS-based learning environment, where both learners and teachers can create learning contents. The more contents increase, the more the number also of learners increases. Therefore, a learner communicates with other learners actively in the system. Thus, the value of the entire environment rises because the user contributes to the learning environment. In this paper, we define the environment as "the participatory learning environment," which is based on the concept of the architecture of participation. A learning cycle on the environment is as follows. First, a learner studies some learning contents, web pages, and so on. Next, he publishes articles to explain what he has understood. Other users read the article and give some comments to his article. Their comments and advices help him reflect about his understanding. The other learners also can reflect their own understanding by discussing them. Some educational institutions have reported practices of teaching/learning with tools such as blog, Wiki, and SNS. However, these tools might be used only for the information exchange in some practices. In that practice, the learning log data are not used efficiently for supporting learners.

The primary features of Web 2.0 are:

(1) Web format services (not package software)
(2) Participatory architecture
(3) High Scalability
(4) Data owing and flexible possibility for reconstruction of data sources
(5) Device free
(6) Utilizing as contents for collected users' data (collective knowledge)
(7) Long tail via self-services.

In this paper, we propose an educational system that encourages learner interaction by "the architecture of participation." We developed a learning management system based on SNS. Our system has two models that describe learners' acquired knowledge and learners' participatory attributes. The learners' acquired knowledge is identified by their articles. The learners' participatory attributes are identified by their learning activities in our system. Moreover, our system can recommend other learner's learning articles as "sub-contents" based on the learner models. Sub-contents are constructed of user's entries and some comments for these entries. In the next chapter, we describe the overview of the SNS-based learning management system.

14.7 Learning Activities in the SNS-Based Learning Management System

We describe the outline of the learning activity in the SNS-based learning management system by using Fig. 14.1. First of all, when a certain user creates a learning course, a learning community for the course is formed. At this time, the course creator participates in the community as a teacher. Other users are registered as a learner by participating in the community. The learners acquire knowledge by studying

contents in the course. Next, when an assignment is given by the teacher, learners publish the learning outcome by posting blog entries. Other learners and the teacher post comments to entries, and evaluate that. The learner who publishes the entry occasionally posts a reply to the comment. It is possible for learners to reflect about their own understanding via interaction with learners or the teacher. This system regards an entry with a set of comments as one "sub-content." Our system enters learner's sub-contents as well as teacher's contents in the database. These contents are used as a learning object for other learners to acquire knowledge and to reflect his understandings. The learning is based on the learning cycle of an acquirement of knowledge, an externalization of knowledge, a reflection of their understandings. The more actively users participate in, the more the amount of contents and the sub-contents increases, and the environment as a whole benefits from this.

14.8 Recommendation Functions of SNS-Based LMS

Figure 14.7 shows a composition of the SNS-based learning management system. The system is composed of three modules; the keyword extraction module, the learner modeling module, and the sub-contents recommendation module. The keyword extraction module extracts important words from contents and sub-contents. The important words included in contents are registered in the keyword database. These keywords are regarded as important concepts of the contents. The learner modeling module generates learner's knowledge model and participation characteristic model from learning activities in the system. The sub-contents recommended for the learner with the sub-contents recommendation module based on the learner model are requested (Fig. 14.8).

Figure 14.9 shows an example of My Page of our system.

14.8.1 Keyword Extraction

Keyword set W is extracted from contents and sub-contents. Our system is not limited to any specific field of study. Therefore, our system needs to core with a wide variety of different technical terms. Preparing a technical dictionary of each field is difficult to extract these technical terms. Therefore, we use data from Wikipedia, a free online encyclopedia for a technical dictionary. Wikipedia covers terms from various fields and is generally up-to-date. The concepts that have an entry in Wikipedia are extracted as keyword set W_w. This set is obtained from dumped Wikipedia Japanese version data.

The system extracts important term sets W_c from contents. The important terms in the W_c are terms that are included in W_w and the contents. The system calculates an important degree of each term in the set W_c by applying the tf-idf method. The tf-idf weight (term frequency–inverse document frequency) is a weight often used in information retrieval and text mining. This weight is a statistical measure used to evaluate how important a word is to a document in a collection or corpus. The tf-idf weight is

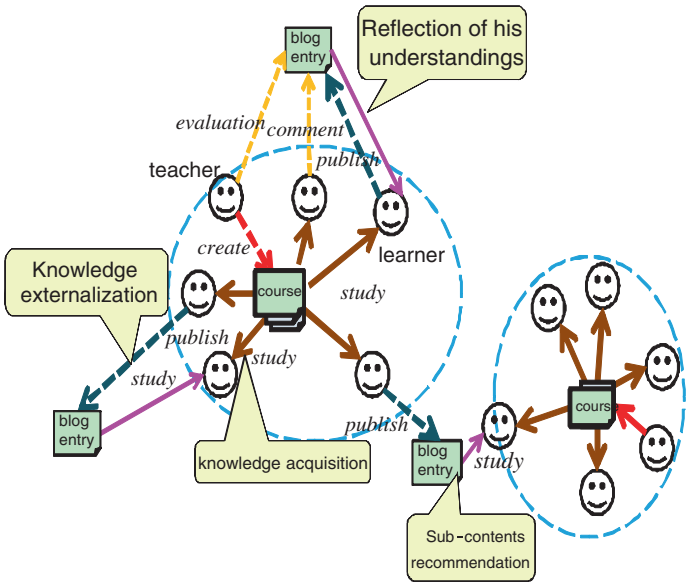

Fig. 14.7 Learning activities in the SNS-based learning management system

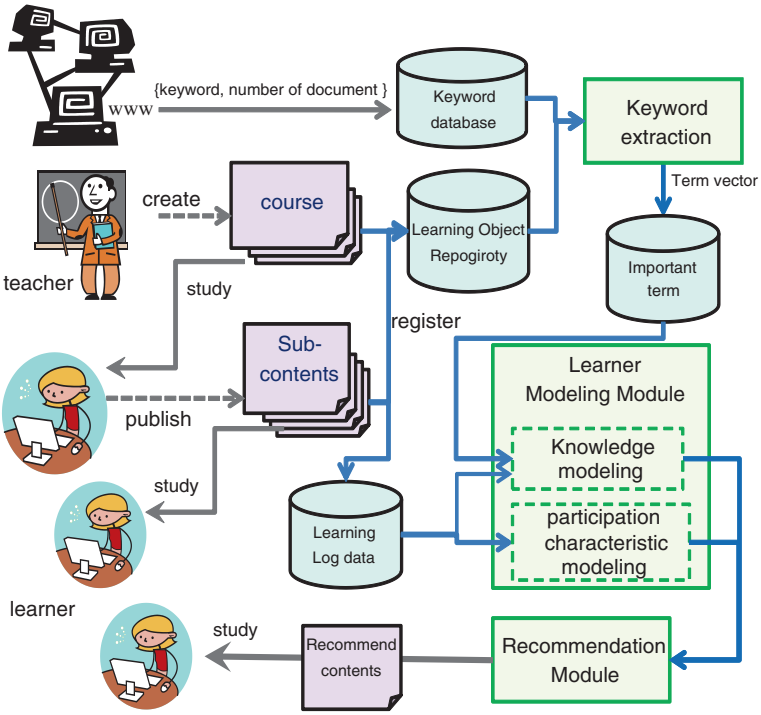

Fig. 14.8 System configuration based on SNS architecture

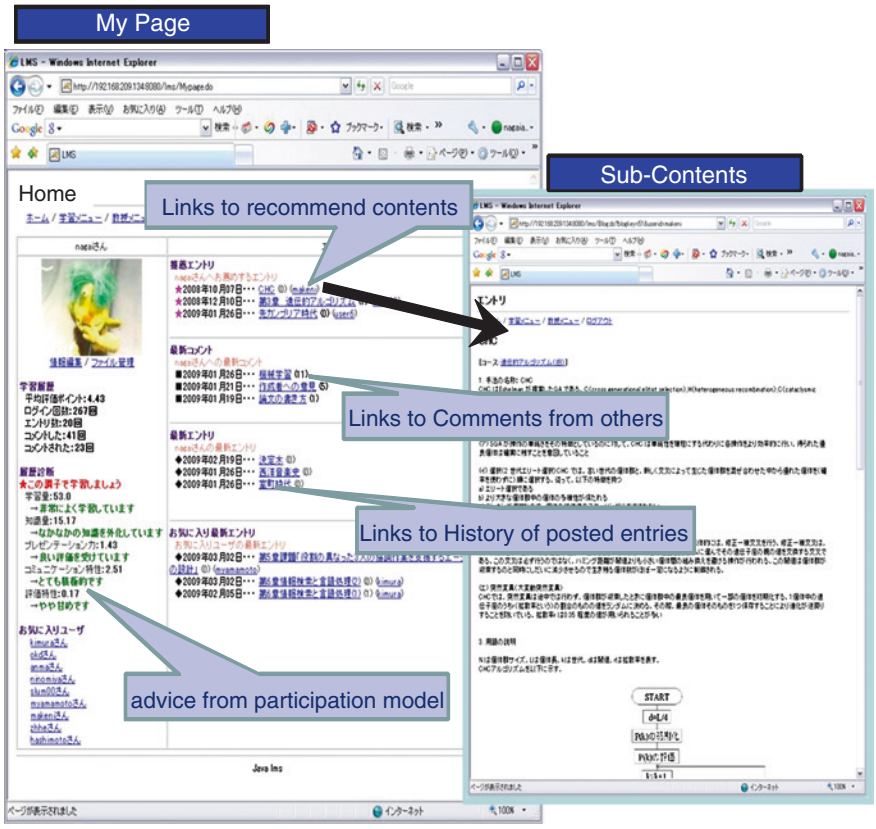

Fig. 14.9 The example of My Page in our system

calculated by *tf-idf*(t, d) = *tf*(t, d)**idf*(t, d). Term frequency, formulated as *tf*(t, d) stands for the number of times the term t appears in the document d. The inversed document frequency can be formulated as *idf*(t) = log(|D|/*df*(t) + 1), where *df*(t) is the number of documents in which term t appears. |D| is the total number of documents in the corpus. In this research, we consider |D| as the total number of all pages in the internet. We set |D| as 35 billion and we consider *df*(t) as the number of pages that includes term t in the internet. The value of *idf*(t) is decided by the retrieval result of a search engine.

14.8.2 Knowledge Model and Participation Characteristic Model

To make the learner efficiently reflect their understandings, the system should recommend appropriate sub-contents according to learner's requests. To support the discovery of suitable sub-contents for the learner, we construct the recommendation module of sub-contents.

The learner modeling module generates the learner model based on learner's activity history in the system. From this, the recommendation module infers the learner's preference based on the learner model and decides what contents to recommend for him/her. The learner model is composed of a knowledge model and a participation characteristic model. The knowledge model describes what concepts the learner is interested in and what concepts the learner has studied. We assume that learners' interest can be inferred based on the keywords extracted from their entries. The knowledge model is calculated by extracting important terms from the entries and the comments that the learner wrote. The participation characteristic model expresses a learner's sociality inferred from learner's activity. The participation characteristic model parameters consist of "learning quantity," " presentation skill," " communication level," and "evaluation tendency" Each attribute is defined as follows:

- *the learning quantity*: How much did the learner study?
- *the presentation skill*: How well did the learner explain the concept that he understood?
- *the communication level*: Is a learner's nature positive or passive when a learner communicate with other learners?
- *the evaluation tendency*: Whether a learner's evaluation to others severe or not?

14.9 New Model of Learning Ecology

Accompanying with the concept of CLOUD computing, various kinds of services are connected among servers and software in a lot of sites/stations, then hardware, software, and web-based contents are shared in this environment. Based on these shared resources, we must create the new model of learning ecology. Figure 14.10 shows the picture of this framework. The principle of learning is the activity—process to change, transform for the shared web contents in learning community, then to discover new facts and to create new artifacts. This learning behavior leads to autonomous and collaborative learning activities "knowledge constructivism."

Table 14.1 shows the relationship (features) on learning gestalt among self-directing, collaborative, and networking based on problem tasks which are used as tools, setting of learning environments.

14.10 Conclusions and Future Works

In this paper, we described the outline of an educational system that encourages learner interaction by "the architecture of participation." We developed a learning management system based on SNS, that is, SNS-based learning management system. Our system has a recommend function of learning objects to achieve active

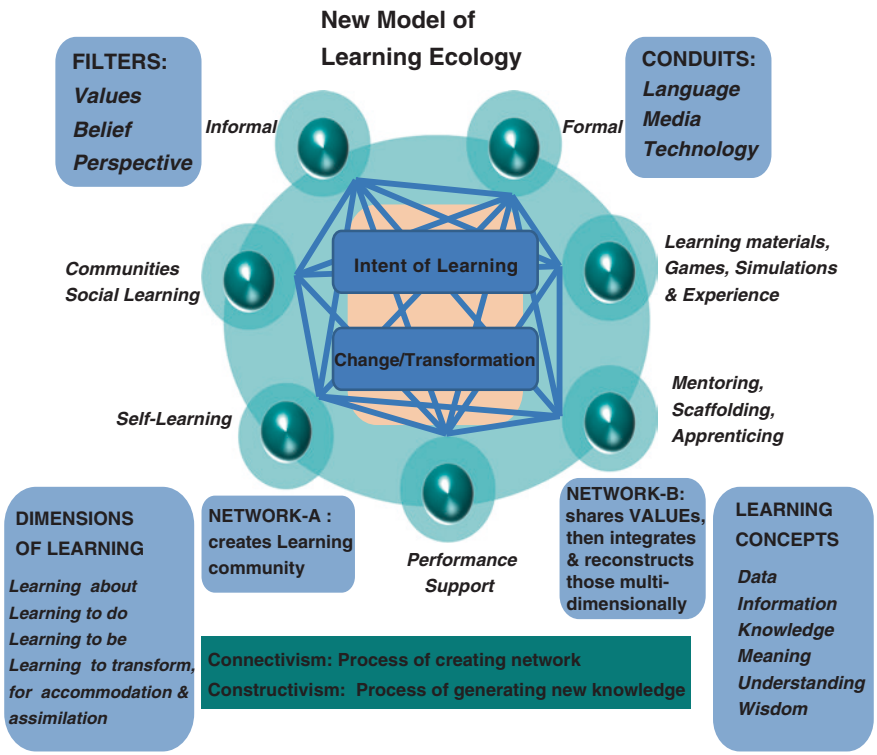

Fig. 14.10 New model of Learning Ecology

Table 14.1 Features of learning environment on self-directing, collaboration, and networking

Self-directing	Problem tasks	Collaborative and social networking
Planning and self-directing individualized learning activities	Tools for visualizing learning activities and tool preference	Grounding for learning activities in group and regulating group activities
Planning personal Learning environments (PLE) using social and other softwar	Sets of interoperable Social software and LMS	Grounding for and Assembling shared group environments with PLEs
Assembling PLEs, and LMS systems beyond Institutional borders	Learning and teaching highly ambiguous settings, experiencing the change	Involving study partners beyond institutional borders

communications among learners. In the future, we will apply the system an actual learning course. We will also evaluate an effectiveness of our system and improve our system to be effective. In the near future, we would like to propose this framework for ISO-JTC1, SC36 (taking up International Standards for Information Technologies of Learning, Education, and Training).

Reference

O 'Reilly, T. (2004). The Architecture of Participation, O'Reilly Media Inc, http://www.oreillynet.com/pub/a/oreilly/tim/articles/architecture_of_participation.html.

Author Biography

Professor Dr. Toshio Okamoto graduated from Kyoto University of Education in 1973 and obtained Master of Educational Psychology from Tokyo Gakugei University in 1975, and PhD from Tokyo institute of Technology in 1989. He was a lecturer at Kanazawa Institute of Technology from 1977 to 1981 and at Tokyo Gakugei University from 1981 to 1983, and then became an associate professor at Tokyo Gakugei University from 1983. He is currently a professor at the University of Electro-Communications (UEC), Graduate School of Information Systems from 1992 and a director of the Center for e-Learning Research and Promotion in UEC. His fields are artificial intelligence and knowledge computing, educational technology and learning science. His research interests include theoretical and application studies/design of e-Learning with artificial intelligence, computer-supported collaborative learning systems and curriculum development in Information education. He standardizes collaborative technology in learning technology as a convener of WG2 (Collaborative Technology) of LTSC/ISO SC36 (Learning Technologies Standards Committee) and he is also a president of Japanese Society for Information and Systems in Education, and a president of Japanese Association for Education of Information Studies. He has held the biggest conference for e-Learning in Japan, where 30,000 people join every year, as an Execution chairman.

Fumihiko ANMA received his B.E. from Tokyo Institute of Technology in 2000 and his Master Degree and PhD Degree from Shizuoka University, Japan in 2002 and 2005 respectively. Presently he is an assistant professor with the Graduate school of Information Systems, The University of Electro-Communications. His research interests include Knowledge Computing, E-learning, Artificial Intelligence, and Software Agents. He is a member of Japanese Society for Information and System in Education, and Japanese Society for Artificial Intelligence.

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Chapter 15
ICT in Indian Higher Education Administration and Management

Marmar Mukhopadhyay and Madhu Parhar

Abstract Indian higher education is undergoing rapid transformation in terms of access, equity and quality. As the GER in Indian higher education is increasing, the government is setting new time-bound targets for achieving 30 % GER. Enhanced allocation of funds, encouraging private initiatives in higher education, collaboration with foreign universities are some of the recent and important developments. These developments are backed by several policy initiatives through the recommendations of National Knowledge Commission, Yashpal Committee Report, four bills pending in the Indian Parliament, 12th five-year plan and Rashtriya Uchchatar Siksha Abhiyan (RUSA). Not figuring in the top 100 or 200 universities have been an issue articulated by several Indian leaders including President of India in several forums. In a way, Indian higher education seems to be charged up focussing sharply on quality. ICT integration is a necessary condition to achieve these goals. There have been several major initiatives in integrating ICT in higher education led by the University Grants Commission. ICT integration in management and administration of higher education has taken deeper penetration in private universities and institutions. With the objective of generating an informed discourse, this chapter documents integrated data and information system in Indian higher education, though it is in its infancy compared to Indian experience of such EMIS in school education especially for planning, monitoring and evaluation, and policy research.

Keywords Indian higher education system · Policy initiatives · Student service management · Academic management · Higher education information system

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R. Huang et al. (eds.), *ICT in Education in Global Context*,
Lecture Notes in Educational Technology, DOI: 10.1007/978-3-662-43927-2_15

List of Acronyms

AIU	Association of Indian Universities
AICTE	All India Council for Technical Education
CABE	Central Advisory Board of Education
IIT	Indian Institute of Technology
INFLIBNET	Information and Library Network
NCHER	National Commission for Higher Education and Research
NMEICT	National Mission on Education through Information and Communication Technology
NKC	National Knowledge Commission
NAAC	National Assessment and Accreditation Council
NCTE	National Council of Teacher Education
NPTEL	National Programme on Technology Enhanced Learning
NUEPA	National University of Educational Planning and Administration
RUSA	Rashtriya Uchchatar Siksha Abhiyan
SAMS	Students Academic Management System
SSA	Sarva Siksha Abhiyan
UGC	University Grants Commission
INSAT	Indian National Satellite System

15.1 Introduction

The Indian higher education system is the third-largest system in the world next only to the USA and China (Wikipedia 2013). The system is expanding fast, with the government policy pitching for raising the GER to 30 % by 2030 compared to approximately 12 % in 2012. Indian higher education is poised to grow much larger during the next 15 years. The agenda of expansion is inclusion and exploiting the demographic dividend of India. This phenomenal growth and expansion in higher education needs to be seen in the context of India's multi-cultural character; a society that houses all 12 major religions of the world, 16 major linguistic groups and an equivalent number of languages in which higher education is offered. With distinguished cultural traditions, mores and values, and the entry of foreign students in many campuses, Indian higher education presents an awesome fusion of colours.

Indian higher education is also undergoing qualitative transformation, the major focus being quality improvement. Quality of Indian higher education has been the subject of scrutiny time and again by various committees appointed by the University Grants Commission (UGC), especially for its role in developing front-line manpower for India's economy and international relations. National Knowledge Commission (NKC) appointed by the Prime Minister, Yashpal Committee (YC) appointed by the then Minister of Human Resource Development and several bills on higher education introduced in the Indian Parliament are some of the indications of this twin emphasis on expansion with quality.

As of now, Indian higher education does not have any authentic comprehensive information system for planned development, although the Ministry of Human Resource Development initiated a project on Survey of Higher Education in India in 2012 (Government of India 2013b).

The scenario of ICT application in Indian higher education provides an interesting study. There are a few initiatives at the national level; however, there is no major articulated policy on ICT in planning and management. There are also some innovative initiatives by certain states, and a few higher education institutions, especially private institutions.

In this chapter, we will present a brief overview of Indian Higher Education to lay down the context in which ICT in educational administration can be studied. We will examine ICT policies, and national, state and institutional initiatives against a framework of ICT application in higher education. We will conclude looking at the 'things to come' in the near future.

15.2 Indian Higher Education System

Education is on the concurrent list—a shared responsibility of the union and state governments. Universities can be set up either with central or state legislation. All central universities and deemed universities have been set up with central legislation. State and private universities have been set up with the approval of the state legislature. Thus, private universities are state universities, except that they are not funded by the state. However, all universities and colleges need the approval of the UGC under appropriate clauses.

Recommended by National Policy on Education 1986, National Assessment and Accreditation Council (NAAC) was set up in 1994 to assess the quality of higher education institutions and accredit them. NAAC, funded by the UGC, functions as an autonomous organisation. Indian higher education is also supported by a few other statutory authorities, namely All India Council for Technical Education (AICTE), National Council of Teacher Education (NCTE) and Distance Education Bureau (DEB) for quality control in technical and management education, teacher education and open and distance education, respectively. Despite such quality control mechanisms on ground, quality has continued to be a crisis in a large majority of higher education institutions; none of the Indian higher education institutions figure in the TOP 200 Universities in the world.

Association of Indian Universities (AIU) is another important player in coordination with higher education. AIU is an association of Indian universities registered under Societies Registration Act; it does not enjoy any statutory powers. The primary concern of AIU is recognition and equivalence of degrees/diplomas awarded by the various universities in India and abroad for admission to higher courses in Indian Universities. The AIU maintains a strong publication programme; it also offers capacity building programmes to higher education personnel.

Indian higher education comprises 574 universities and 35,539 colleges (as on 31.3.2012) with an estimated enrolment of 20.3 million students (Table 15.1).

During the years 2001–2004, enrolment grew at more than 6 % per year. Enrolment grew at an average of nearly 9 % per year during the last 8 years. However, growth in enrolment is not uniform across all levels (Table 15.2).

Student enrolments in affiliated colleges far outweigh enrolment in university departments. 89.38 % of undergraduate students are enrolled in affiliated degree colleges; even at the postgraduate level more than 72 % students are enrolled in

Table 15.1 Growth of enrolment in higher education (2001–2012)

Year	Enrolment	Increase over preceding year	Percentage increase
2001–2002	8,964,680	565,237	6.7
2002–2003	9,516,773	552,093	6.2
2003–2004	10,201,981	685,208	7.2
2004–2005	11,038,543	836,562	8.2
2005–2006	12,043,050	1,004,507	9.1
2006–2007	13,163,054	1,120,004	9.3
2007–2008	14,400,381	1,237,327	9.4
2008–2009	15,768,417	1,368,036	9.5
2009–2010	17,243,352	1,474,935	9.4
2010–2011	18,670,050	1,426,698	8.3
2011–2012[a]	20,327,478	1,657,428	8.9

[a] Provisional

Source UGC annual report 2011–2012; (http://www.ugc.ac.in/pdfnews/Annual_Report_2011-2012_English_Final.pdf)

Table 15.2 Student enrolment[a]: level-wise: 2011–2012

Sl. No	Level	University departments/ university colleges	Affiliated colleges	Total (% to grand total)	Percentage in affiliated colleges
1.	Graduate	1,853,109	15,602,420	17,455,529 (85.87)	89.38
2.	Post-graduate	693,864	1,798,608	2,492,472 (12.26)	72.16
3.	Research	127,780	33,092	160,872 (0.79)	20.57
4.	Diploma/ certificate	132,620	85,985	218,605 (1.08)	39.33
	Grand total	2,807,373	17,520,105	20,327,478 (100.00)	86.19

[a] Provisional

Note Research includes M.Phil and Ph.D

Source UGC annual report, 2011–2012

Table 15.3 Student enrolment: faculty-wise[a]: 2011–2012

Faculty	Total enrolment	Percentage to total
1. Arts	7,539,495	37.09
2. Science	3,789,967	18.64
3. Commerce/management	3,571,083	17.57
4. Education	732,627	3.60
5. Engineering/technology	3,261,590	16.05
6. Medicine	715,706	3.52
7. Agriculture	97,313	0.48
8. Veterinary sciences	28,504	0.14
9. Law	373,246	1.84
10. Others	217,947	1.07
Total	20,327,478	100.00

[a] Provisional
Source UGC annual report, 2011–2012

the affiliated degree colleges. Overall, 86.19 % enrolment in higher education institutions is in the affiliated colleges. There is wide regional variation in student enrolment as well as faculty-wise enrolment (Table 15.3).

Further disaggregation of enrolment data indicates that the largest proportion of students is enrolled in Arts (37.09 %), followed by Science (18.64 %), Commerce and Management (17.57 %) and Engineering and Technology (16.05 %). Enrolment in other professional courses range between a low of 0.14 % in Veterinary Sciences to 3.49 % in Medicine.

Thus, expansion of higher education has not been uniform. Special concern exists about the low enrolment in professional courses that offer better employment opportunities to young graduates and skilled manpower for the service and production sectors. Another important concern is the high enrolment in Arts courses with the lowest employment potential.

15.3 Higher Education Policy Initiatives

A description of the Indian higher education scenario will be incomplete without taking a close look at some of the major policy initiatives by the Government of India. We take a brief overview of the recommendations of the National Knowledge Commission (NKC 2005); Committee on 'Renovation and Rejuvenation of Higher Education' (2008) and the four bills on higher education pending before the Indian Parliament. We will present some details from the 12th Five Year Plan and Rashtriya Uchchatar Siksha Abhiyan (National Mission on Higher Education) that lays down the road map for future developments in Indian higher education.

15.3.1 National Knowledge Commission

The NKC summarises the agenda of reform in higher education system under three broad heads, namely (1) expansion, (2) excellence and (3) inclusion.[1]

The NKC recommends creating 'many more universities', changing the system of regulation of higher education, enhancing funding and establishing 50 national universities as the major strategies for expansion of higher education. NKC proposes establishment of 1,500 universities and also 50 national universities as pace-setting institutions that can provide education of the highest standard. Such universities can be set by the government, or non-government bodies with liberal funding. NKC rightly argues that 'such expansion would require major changes in the structure of regulation'.

Instead of multiple regulatory authorities like the UGC, AICTE, NCTE, DEB, etc., NKC recommends establishment of an Independent Regulatory Authority for Higher Education (IRAHE) by an Act of Parliament that would be responsible for setting the criteria and deciding on entry to higher education institutions.

The NKC strongly recommends increase of public funding of higher education to 1.5 or 25 % of the total allocation to education—6 % of the GDP. However, NKC also recognises that even 6 % would be inadequate and recommends diversification of funding through better utilisation of land available to universities, rationalising fees to fetch at least 20 % of the total expenditure in universities.

The NKC proposes to achieve excellence through a three-fold strategy comprising (1) reforming existing universities, (2) restructuring undergraduate colleges and (3) promotion of enhanced quality.

The NKC strongly advocates 'inclusion' in higher education. It recommends introduction of an extensive National Scholarship Scheme targeting economically underprivileged students and students from groups that have been historically socially disadvantaged to facilitate their participation in higher education. Interestingly, the NKC is silent on the need for inclusion of differently abled students, though according to the law of the land, special provisions must be made to encourage physically and mentally challenged students to participate in higher education to the best of their capabilities.

15.3.2 Renovation and Rejuvenation of Higher Education (Yashpal Committee Report)

The Yashpal Committee was originally set up as UGC/AICTE Review Committee with the terms of reference restricted to the review of UGC and AICTE—roles and structures.[2] The scope of the committee was later enlarged to cover issues related to

[1] http://knowledgecommission.gov.in/.

[2] http://mhrd.gov.in/sites/upload_files/mhrd/files/YPC-Report_0.pdf.

Renovation and Rejuvenation of Higher Education (The report made comprehensive recommendations on higher education mostly overlapping with the recommendations of NKC). Some of the salient recommendations are:

- All universities must be research-cum-teaching institutions; teach both undergraduate and postgraduate classes.
- On financing and provision, its main recommendations include common benefits for both central and state universities; complementary funding through philanthropy and mobilising alumni through appropriate changes in regulations; provision for hiring professional fundraisers and investors to attract non-government funding sources.
- To improve quality of teachers and establish accountability, YC recommends student assessment of teachers. It also recommends easing out teachers whose feedback record remains poor in successive years.
- YC makes a series of recommendations on regulatory mechanisms like submission of all private universities to a national accreditation system; welcome foreign universities only from the list of Top 200 and be subjected to all the regulations applicable to Indian universities including awarding Indian degrees.
- The most important recommendation, similar to that of NKC, on regulatory mechanism is setting up an overarching new regulatory body—the National Commission for Higher Education and Research (NCHER) to subsume the functions of UGC, AICTE, NCTE and other such statutory organisations.

15.3.3 Four Bills on Higher Education

The Ministry of HRD has introduced four bills in the Parliament that intend to shape the future of Indian higher education.[3] The four bills are: National Accreditation Regulatory Authority for Higher Educational Institution; Foreign Educational Institutions (Regulation of Entry and Operations) Bill, 2010; Prohibition of Unfair Practices in Technical Educational Institutions, Medical Educational Institutions and University Bill, 2010; and Educational Tribunal Bill.

The intention of all these four bills is to assure quality in higher education. However, the tenor of all the bills represents two major trends, namely control orientation and centralization, which is against the fundamentals of a federative democratic polity. As would be evident, ICT as a means of improved quality of higher education and governance does not find a place in the policy initiatives.

[3] Since these bills are still pending in the Parliament and not passed, we are not providing the details here. The Higher Education Bills can be accessed at http://www.prsindia.org.

15.3.4 Rashtriya Uchchatar Siksha Abhiyan (RUSA: National Higher Education Mission)

RUSA was initiated in 2012 by the Ministry of Human Resource Development with UGC as the nodal agency for heading the mission.[4] RUSA follows the footsteps of SSA (Sarva Siksha Abhiyan—Education for All Mission) and RMSA (Rashtriya Madhyamik Siksha Abhiyan—National Secondary Education Mission). In a way, it is logical since higher education stands on the shoulder of secondary education as much as secondary education depends upon elementary education. In tune with the SSA and RMSA, RUSA also has the twin focus of expansion and/with quality. In order to achieve these twin goals, the document deals elaborately with institutional mechanisms of setting up new institutions, new courses, empowering higher education institutions with autonomy, encouraging private initiative, entry of foreign universities and a variety of other interventions.

15.4 ICT in Indian Higher Education Management

At the backdrop of the Indian higher education scenario and the policy initiatives described earlier, it will be useful to examine ICT in higher education management within a meaningful framework (Fig. 15.1).

There are seven major domains of management of higher education. These are academic, human resources, infrastructure, finance, student services, administrative management, and linkage and network (Mukhopadhyay 2005). These and other areas can be classified into three broad domains, namely Academic Management, Student Services Management and Administrative Management.

Further, ICT in management of higher education has to be examined at three different levels, namely national, state and institutional levels. Applications of ICT in institutional management are at the affiliating university and unitary institute level, namely unitary universities and colleges. For example, although every state and individual higher education institute can have its own ICT policy in higher education, in India, policy is ascribed to the national setting. In the following pages, we will deal with various issues of ICT in higher education management and also refer to the state and institutional initiatives and innovations in ICT in management of higher education.

15.5 ICT Policy in Higher Education

With the explosion of ICT, India explored the use of computer and Internet-based ICTs for education. EDUSAT—India's first dedicated satellite on education was launched in 2004 (Mukhopadhyay 2006).

[4] http://www.ugc.ac.in/ugc_notices.aspx?id=224.

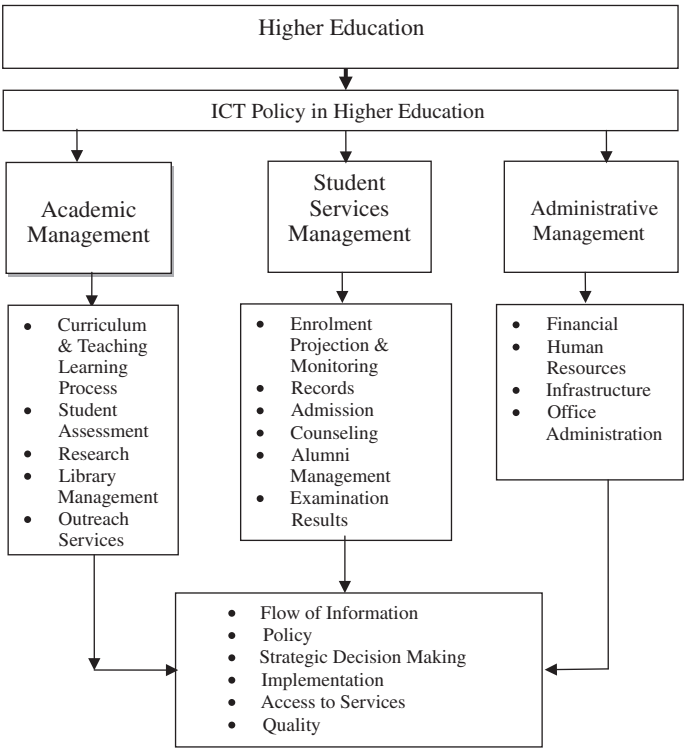

Fig. 15.1 Framework for use of ICT in higher education management

Government approved the National Policy on Information Technology only in 2012, (Government of India, 2013c http://www.pib.nic.in/newsite/erelease.aspx?relid=87875). The aim of the policy is to 'leverage ICT to address Nation's Developmental Challenges'. The policy is oriented towards the use of ICT to promote decentralisation and empowerment of citizens. One of the objectives of the National Policy is to 'leverage ICT for key Social Sector initiatives like *Education*, Health, Rural Development and Financial Services to promote equity and quality' [http://www.pib.nic.in]. Unlike school education where there is an articulated *National Policy on Information and Communication Technology (ICT) in School Education*, IT for Change (2013) (http://www.itforchange.net), there is no separately articulated ICT policy in Indian higher education. ICT policies in higher education, hence, have to be derived out of different documents of the UGC and government of India. We refer to two recent documents, namely the 12th Five Year Plan that lays down the road map of educational development during the next five years and Rashtriya Uchchatar Siksha Abhiyan (RUSA) or National Mission on Higher Education that provides long-term goals in Indian higher education.

The 12th FYP (Government of India, 2013a) recognises that the 'The country lacks current and comprehensive data for evidence-based policymaking and effective planning…'. The document goes on to clarify the need for a comprehensive data book

with complete facts and figures, and trends across time and space, and with disaggregation at state level. The 12th FYP also recommends aligning the Indian higher education data with International Standards Classification of Educational Data (ISCED 2011) [http://www.uis.unesco.org/Education/Documents/isced-2011-en.pdf]. This will help develop a better understanding of the developments in higher education in the country.

To translate these policy perspectives, the Ministry of Human Resource Development, Government of India constituted a taskforce. On the basis of its recommendation, an online survey of higher education in India has been started. Both private and public institutions of higher education will be responsible for providing 'reliable and timely data on student enrolment, and other 'strategic information'. The Ministry intends to use this web-based higher education data management system for tracking and monitoring the progress in higher education in different regions of the country. It further enunciates that the 'Higher education database management system can also provide the desired data to various stakeholders such as national academic depository, planning bodies, research entities, students and other academic bodies'.

ICT does not figure in the RUSA document in any significant manner, except for one reference to establish a Management Information System in Higher education (http://www.mhrd.gov.in/). The only additional input is seeking state's involvement in developing the MIS. It asks states to take advantage of the high speed connectivity already established through the National Knowledge Network (NKN) National Knowledge Network (2013).

The major policy initiative that can be derived from these two main government documents—the NKN and 12th FYP—is to develop a comprehensive database on higher education that can be used for data and information-based policy making, and assessing and monitoring developments in higher education in India.

The story of the development of educational database and educational management information system would remain incomplete without reference to National University of Educational Planning and Administration (NUEPA), former National Institute of Educational Planning and Administration (NIEPA), for, it pioneered educational management information systems in India (Box 1).

Box 1: National University of Educational Planning and Administration, New Delhi

National University of Educational Planning and Administration (NUEPA) is a specialist institution on educational policy, planning, management, and programme evaluation. The university is fully funded by Government of India; it is the think tank of the Ministry of Human Resource Development of the Government of India.

NUEPA, then NIEPA pioneered the development of educational management information systems in India; strongly supported by UNICEF. Beginning with the development of a database on the District Primary Education Programme (DPEP) in the early 1990s, NIEPA created District

Information System in Education (DISE) that is now recognised as India's official database on primary education. With the enactment of Right to Education Act in 2009, this database has been modified and upscaled to cover elementary education (grades 1–8). As the government of India moved on towards universalisation of secondary education based on the CABE Report, the database has been extended to cover education up to 12th grade. The secondary education database was begun as Secondary Education Management Information System (SEMIS). Later, the databases on elementary education and secondary education were merged together to create a comprehensive school education database—U-DISE.
Only recently, NUEPA was assigned the responsibility of developing educational management information system in higher education by the Ministry of Human Resource Development, Government of India.

It is evident that, (a) NIEPA pioneered ICT in educational management in India, and (b) educational management information system had a bottom-up approach—it began with primary education, moving up to cover elementary and secondary grades. Higher education has lagged behind and is still in its infancy as far as the educational database is concerned.

15.6 ICT in Academic Management

Academic Management comprises of several areas like curriculum and teaching-learning process, student evaluation, research, library management and management of extension and outreach programmes.

Application of ICT in higher education began with, and almost remained confined to, Curriculum Development and Teaching-Learning Process. It began with educational television programmes under Country Wide Classroom Project of the UGC. In the draft of the Sixth Five Year Plan of India, UGC proposed the establishment of centres of mass communication and educational technology in selected universities in the country. With the launch of INSAT in 1982, the UGC—INSAT television project, named 'Countrywide Classroom' was launched to bring qualitative and quantitative improvements in higher education. CWC was launched in 1984. The objectives were to upgrade, update and enrich the quality of education at tertiary level. The target audience of CWCR project were the undergraduate college students studying in colleges located in the smaller towns and rural areas of India. However, a large non-student population also view these programmes. These programmes were produced in EMRCs and AVRCs. UGC provided television sets to colleges to enable viewing by students.

In recent years, the Ministry of Human Resource Development initiated several ICT Missions to improve the quality of teaching–learning process in higher education.

15.6.1 National Mission on Education Through Information and Communication Technology (NMEICT)

Under this Mission 20,000 institutions of Higher Education and nearly 10,000 University Departments were to be provided with connectivity, beginning with a minimum of five for each one of them.[5] The Central Government will bear 75 % of the connectivity costs for 5 years, even for institutions not belonging to it. Content generation and connectivity along with provision for access devices for institutions and learners are the major components of the mission. So far, nearly 400 universities have been provided with 1 Gbps connectivity, or have been configured under the scheme and more than 14,000 colleges have also been provided VPN connectivity. Indian Institutes of Technology (IITs) campuses act as hubs for NME-ICT and others.

Within the large framework of NME-ICT Mission, seven IITs (Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and Indian Institute of Science (IISc) took another initiative for creating course contents in engineering and science under the banner, National Programme on Technology Enhanced Learning (NPTEL).

NPTEL programmes are largely video recordings of classroom lectures interspersed with visuals by the faculty members of the IITs and IISc. These video lectures are freely accessible by everyone independent of their geographic location and are in great demand among students because of two reasons. First, these are lectures by teachers from prestigious IITs; and for young Indian students admission in IITs is the biggest dream. Second, technical institutions in India have a serious deficiency of academic staff (estimated at about 40 %) for a very long time. These video lectures fulfil that huge gap and with quality inputs.

The programmes work well with highly motivated students whose future is relatively certain. However, the programmes are largely lectures and lack the support of science in human learning. As a result, they do not provide a viable model for ICT integration in other areas of higher education. Further, such programmes do not have the mission to ensure learning, hence, there is no mention and application of Learning Management System (LMS).

Online courses are yet another application of ICT in higher education. Though there are a few initiatives in online courses by the IITs, Indira Gandhi National Open University (IGNOU), and a few other private universities, these are still at infancy.

Another area of application of ICT in academic management is student evaluation. However, there are not many instances of online or on-demand examination based on a computerised question bank. IGNOU ran on demand examination for a few years, but discontinued.

There have been some major development initiatives in ICT in Research and Library management. The NKN and Information and Library Network (INFLIBNET) are two major initiatives. The NKN is a state-of-the-art multi-gigabit

[5] http://www.nmeict.iitkgp.ernet.in/Analogmain.htm] {http://www.it.iitb.ac.in/nmeict/home.do;jsessionid=47BCCAEAB9A7BAFD8C8B7B2E768B6750.

pan-India network for providing a unified high speed network backbone for all knowledge-related institutions in the country. The purpose of such a knowledge network goes to the very core of the country's quest for building quality institutions with the requisite research facilities and creating a pool of highly trained professionals. The NKN will enable scientists, researchers and students from different backgrounds and diverse geographies to work closely for advancing human development in critical and emerging areas.

The INFLIBNET was started in 1996 to network all the Libraries of Higher Education institutions in India. It created virtual networks of people and resources in academic institutions to provide efficient access to knowledge. Among the various activities of INFLIBNET, the UG—Infonet Internet Connectivity programme provides Internet bandwidth from 256 kbps to 2 Mbps to all the universities in the country. Another activity is the development of the Union Catalogue of Resources called "IndCat" (Indcat 2013, http://indcat.inflibnet.ac.in/,) which is an important source of bibliographic information that can be used for collection, development, inter-library loans as well as for copy cataloguing and retro-conversion of bibliographic records.

One of the early initiatives, UGC—Infonet Connectivity Programme began in 2002 to network university campuses with the state-of-the-art campus-wide networks. Under UGC—Infonet, 10 Internet bandwidths were provided to more than 180 universities on fibre-optic leased line. After the launch of NKN and NME-ICT, UGC advised the universities to join NKN and NME-ICT, and wound up UGC-Infonet.

Besides these national initiatives of connecting libraries, a large number of universities in India maintain a computerised database for library management that includes procurement, accession, issue, and return of books and journals by readers and write-off procedures.

Open Education Resources and web portals are mechanisms for academic outreach. NPTEL is an example of academic outreach. Another important outreach initiative is Sakshat. It is a portal under NME-ICT. The portal comprises

- Student's Corner to 'Support self learning through virtual classes and testing services, nurture learners through guidance and counselling. Manage Scholarship and National Merit Scholarship Scheme'.
- Teacher's Corner to 'provide link to teachers' empowerment programmes'
- Knowledge Plus, 'to explore the world of web-based knowledge resources through e-books, e-journals and OER'
- Interact 'to communicate and share knowledge with teacher/mentor or peer group in real time and asynchronously' (Sakshat, 2013).

15.7 ICT in Student Services Management

Student Services Management comprises enrolment projection and monitoring, counselling and admission, examination results, records and alumni management.

As mentioned earlier, Indian higher education has witnessed massive expansion and diversification. This expansion, however, is not the result of planned action. There is no college mapping or course mapping across geographical locations. Naturally, there are huge regional disparities, gender disparity and rural–urban disparities in the provisions of higher education and enrolment; and a skewed distribution in the enrolment of students in arts versus other courses. More than 90 % of higher education students are in undergraduate courses and more than 90 % attend degree colleges. But these are not backed by any plan. They are by default. Though the Government of India has now set targets of enhancing enrolment in higher education, there is actually no projection of enrolment based on any meaningful database except for specific plan periods (Duraisamy 2008). Nonetheless, several individual researchers have projected enrolment in higher education using computerised data modelling on alternative scenarios (Parhar 2002a, b; Sharma 2012). Although this is a potential area for ICT intervention, Indian higher education is yet to make full use of it.

Pressured by the socio-economic aspiration of young people, enrolment is growing at an average of 6 % per annum. The gross number of students seeking admission even at this level of 6 % annual growth is huge. Student admission, especially in conventional universities and colleges is largely managed manually. Nonetheless, there are several state and institutional initiatives in ICT-driven counselling[6] and admission. Odisha and Maharashtra provide examples of state initiatives in ICT supported student services management (Boxes 2, 3 and 4).

Box 2: Students Academic Management System of Odisha

Students Academic Management System (SAMS) was initiated by the Department of Higher Education (DHE), Orissa in collaboration with Orissa Computer Application Centre, IT Department (OCAC), and Cybertech Software and Multimedia Private Limited (CSM) in 2009. The system was initiated because most universities and colleges in the state were not adequately equipped to cater to the demand for greater access to better quality higher education institutions. The key objective of SAMS was to ensure that students and guardians can access the admission process in a simple, economical and less time-consuming manner. The second objective was to capacitate college administration to ensure effective and efficient information management and dissemination during the admission process.

[6] In Indian Higher Education, the word ‘Counselling’ is used to mean advising the candidates about the courses that he/ she can be admitted to; also providing allied information on the course and its prospects.

The programme is supported by a well-integrated institutional structure, technical assistance, and continuous monitoring and evaluation of the system. The online database supported by SAMS is maintained and disseminated at three levels. At the block and district levels, it is maintained by 380 SAMS resource centres and 30 SAMS nodal colleges, respectively. At the state level, the Central SAMS laboratory (Bhubaneswar) plays a crucial role in coordinating the operation of the programme at the block and the district level. Experts from the department of higher education, IT department and OCAC train around 1,200 personnel, from different colleges, at the central laboratory for enhancing their technical skills and understanding about SAMS and ensuring the effective management of the admission process.
At present, almost 1,200 colleges have been integrated into the system. In the process, this expansion has ensured improved service delivery, access to better quality education, eliminating redundancy in the admission process, universalising better quality higher education and improved management of the education system (Governance Knowledge Center 2013).

Source http://indiagovernance.gov.in/bestpractices.php?id=2085.

Box 3: Digital University Framework of Maharashtra
Digital University Framework is a project started in 2006 in all universities in the state of Maharashtra. It is a web-based software framework to manage student lifecycle in Universities and Colleges in Maharashtra. This framework offers direct facilitation services to Universities, its affiliated Colleges and their students very fast, affordably, with high quality, and mass personalization and configurability. The framework enables the student to acquire informative services.
The objective of Digital University Framework is to provide services to students, all affiliated colleges and the University. The project provides:

- Personalised Services at the doorstep of students, reduced data duplication efforts at various levels due to single time student data entry;
- System generated outputs with no errors because of reduction in student cycles to colleges and universities. Direct student facilitation, students' online requests for various services through web portals; and
- Reduction in workload of university and college staff due to paperless transactions (eIndia Education Summit, 2011).

Source http://eindia.eletsonline.com/2013/Hyderabad/Education/digital-university-framework-maharashtra-knowledge-corporation-limited/.

Box 4: Anna University: Tamil Nadu
In Tamil Nadu, Anna University[7] provides an important study of ICT in student admission management in a state.

a. *Tamil Nadu Engineering Admissions (TNEA)*
Anna University conducts counselling for candidates to over 500 Engineering Colleges in Tamil Nadu. The counselling process involves 150,000 (approximately) candidates for more than 67 branches in over 500 Engineering Colleges. All the computerisation activities related to TNEA are developed and managed by RCC. The way in which the whole process is organised and carried out has received all-round appreciation from both the public and the press.

b. *Tamil Nadu Common Entrance Test (TANCET)*
Anna University conducts year after year, the TANCET for M.E/M.Tech. candidates offered by colleges situated in Tamil Nadu. TANCET for MBA and MCA candidates is offered by Anna University for CEG Campus. The processing works relating to TANCET are carried out by the RCC.

c. *Tamil Nadu Common Admissions (TANCA)*
Anna University conducts the selection of candidates to Engineering Colleges in Tamil Nadu for M.E/M.Tech. Programmes and selection of candidates to CEG campus, Anna University Chennai for MBA and MCA Programmes. The process involves counselling nearly 17,000 candidates for more than 254 branches in over 110 Engineering Colleges. Counselling is conducted and the secured communication, related software design, development and management is done by RCC (Ramanujam Computing Center, 2013).

Source http://www.annauniv.edu/rcc/projects.php.

[7] *Anna University (AU)*, ranked ninth best university in India, encompasses within it one of the oldest technical institutes in the world and has a history spanning 218 years (As of 2012). It was renamed 'Anna University' on 4 September 1978 as a unitary university. It became an affiliating university in 2001, absorbing about 250 engineering colleges in Tamil Nadu. Between 2007 and 2010 it was split into six universities, namely Anna University, Chennai, Anna University of Technology, Chennai, Anna University of Technology, Tiruchirappalli, Anna University of Technology, Coimbatore, Anna University of Technology Tirunelveli, and Anna University of Technology, Madurai. On September 14, 2011, a bill was passed to merge the universities. Anna University has once again become a single affiliating university for engineering colleges all over Tamil Nadu from August 1, 2012 (Sources of information Wikipedia Oct 20, 2013 and www.annauniv.edu/).

Use of ICT in student admission management is relatively common among private universities and also in open universities. For example, in IGNOU, beginning with admission notification on the net/website, call for online application, processing, fee transaction and confirmation of admission, and all such other services helps the university increase transparency and accountability. The services also facilitate responding to students' queries.

A related issue of student services is examination management. ICT is extensively used in examination management across all types of higher education, especially in processing of marks/grades, generating mark sheets and certificates, and publication of results. For example, in IGNOU, students' grade cards are posted on the website which the student can access with her enrolment number as the password. Question Banking and Examination Management are two modules of e-governance in Lovely Professional University, Jalandhar.

The extensive use of ICT in examination management, compared to that in other areas, is largely due to the sensitivity of the subject, because it demands accuracy. Also, the sheer magnitude of the work of examination management due to the massive number of candidates makes it necessary to use ICT for examination management; the relative advantages of technology, namely accuracy and time saving, are also the reasons for better adoption of technology in examination management.

15.8 ICT in Administrative Management

There are four major areas under administrative management, namely financial management, human resource management, management of infrastructure and office management including management of records and communications. ICT application in administrative management is neither uniform across all higher education institutions nor across various areas of administrative management.

A good example of the comprehensive use of ICT in administrative management is that of Lovely Professional University (LPU) in Jalandhar. LPU has created a University Management Information System comprising eight modules, namely Admissions, Human resources, Transportation, Examination, Question bank, e-Governance, Stock accounts, Payment Tracking System and Document Management System (Lovely Professional University. University Management System, 2013).

Though a majority of the universities do not have comprehensive application of ICT in management, financial management is relatively a popular area in ICT application. In a majority of the institutions, ICT application in financial management covers budgeting, staff salary and perks, financial control and accounting. The level of application varies from minimum application of a Tally kind of software to tailor-made software.

Box 5: IGNOU's ERP
IGNOU took the initiative to automate its Financial and core HR activities as part of ERP. To do so, IGNOU selected M/s TCS as a systems integrator under turnkey project and started implementation of the project in 2007. As part of it, established Data Centre with Servers (HP Blades) and Storage (SAN Storage of 5 TB), Application customisation/development for Finance and core HR activities using PeopleSoft's Finance and Supply Chain Management (FSCM) and Human Capital Management (HCM), Backend Database using Oracle 10g, Campus Networking and Digitisation. IGNOU named the system as ODLSOFT System. As most of its financial activities are performed through ODLSOFT system, the university opens and closes the financial year with the system itself. The ODLSOFT System improved the University's financial and core HR activities a lot in terms of transparency, timely completeness, responsiveness and accountability (Rao 2012).

Another area of relatively common application of ICT is human resource management or personnel management. This application largely deals with recruitment, posting, increments, promotion, pay revision, retirement benefits and leave management. Document management, in a majority of the higher education institutions, is still manual. There are very few instances of ICT integrated document management like in LPU where the agenda is paperless office or reducing the expenditure on stationery. Similarly, ICT application in infrastructure management is still not a common area.

15.9 Higher Education Information Systems: The Upcoming Story

As mentioned earlier, Indian higher education does not have a comprehensive database. The 12th Five Year Plan (FYP), in the chapter on quality acknowledged, **'**One of the major lacunae in our system is the insufficient networking and poor database on the Indian Higher education system and non-availability of one window information of available human resource'. The 12th FYP decided to create a National Educational Resource Portal to make data of all the educational institutions of the country available; it also stipulated that uploading data on the portal would be mandatory. The proposed contents of the portal would be (we quote):

1. 'Human resources available in the Indian institutions of higher education;
2. Availability of experts in various fields for teaching, examinations, research collaboration, industrial consultancy;

3. Transparency of activities, display of new initiatives, innovative ideas—for sharing and mutual benefits;
4. Posting of model teaching and research programmes and the syllabus followed in the various institutions; Inclusive and Qualitative Expansion of Higher Education
5. Display of the examination systems, academic, administrative and examinations reforms initiated;
6. Model guidelines for the Choice-based Credit System (CBCS); and
7. Display of needs and vacancies of all educational institutions both in staff positions and the vacancies in several programmes offered'.

The 12th FYP bookmarks the need to create space for 'modern management techniques with qualified, professionally trained and pro-active administrators suited for the 21st century requirements of e-governance, knowledge and professional skills' when higher education institutions are still being run with '19th Century tools'. The document also laments that higher education lags in the use of ICT in governance compared to that in the administration and management of Railways, Revenue, Power, Airlines and other sectors. Though the 12th FYP underlines the need of ICT in administration and e-governance, it soft pedals the issue by saying 'The 12th FYP should (please read 'should' as desirable, and not obligatory and accountable) target automation of administration and e-governance in the UGC and all the Universities/Colleges' (http://12thplan.gov.in/).

It is important to mention that not many people engaged in higher education institutions have personal access to computing devices, though penetration of mobile phones is near universal. The government, as of now, does not have any policy to provide computing facilities to the faculty members of universities and colleges. The ICT, hence, is not yet a culture of higher education.

15.10 Conclusion

A critical study of the developments in Indian higher education and use of ICT in its administration reveals some interesting trends and patterns. First, as India gave up her conservative manpower planning approach to higher education, there has been a phenomenal expansion and diversity in Indian higher education since independence. Beginning with a few tiny colleges and universities at the dawn of independence, Indian higher education has emerged as the third largest system in the world. The diversification and flexibility in policies have provided space to the private providers of higher education. As of now (2013), private institutions of higher education constitute more than 60 % of the colleges and 29 % of the universities [Source: FICCI & EY: Higher Education in India: Twelfth Five Year Plan (2012–2017) at http://www.daaddelhi.org/imperia/md/content/passage-to-india/higher_education_institutions_.pdf] (Higher Education Institutions, 2013).

The expansion of higher education has been guided more by considerations of human capital formation and people's aspiration. Only recently, demographic dividends and improving the GER in higher education found space in the Indian discourse in higher education. No wonder that despite expansion and diversification of Indian higher education, there is no comprehensive database and management information system in higher education. The technology intervention in higher education, especially initiatives of the union government remained confined to academic processes only. Only in the 12th FYP, there is an articulated policy on developing a national resource portal.

However, several state governments and higher education institutions inducted ICT in management, based on the perceived needs and realisation of the potential of ICT in making governance much less expensive while increasing efficiency and effectiveness.

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