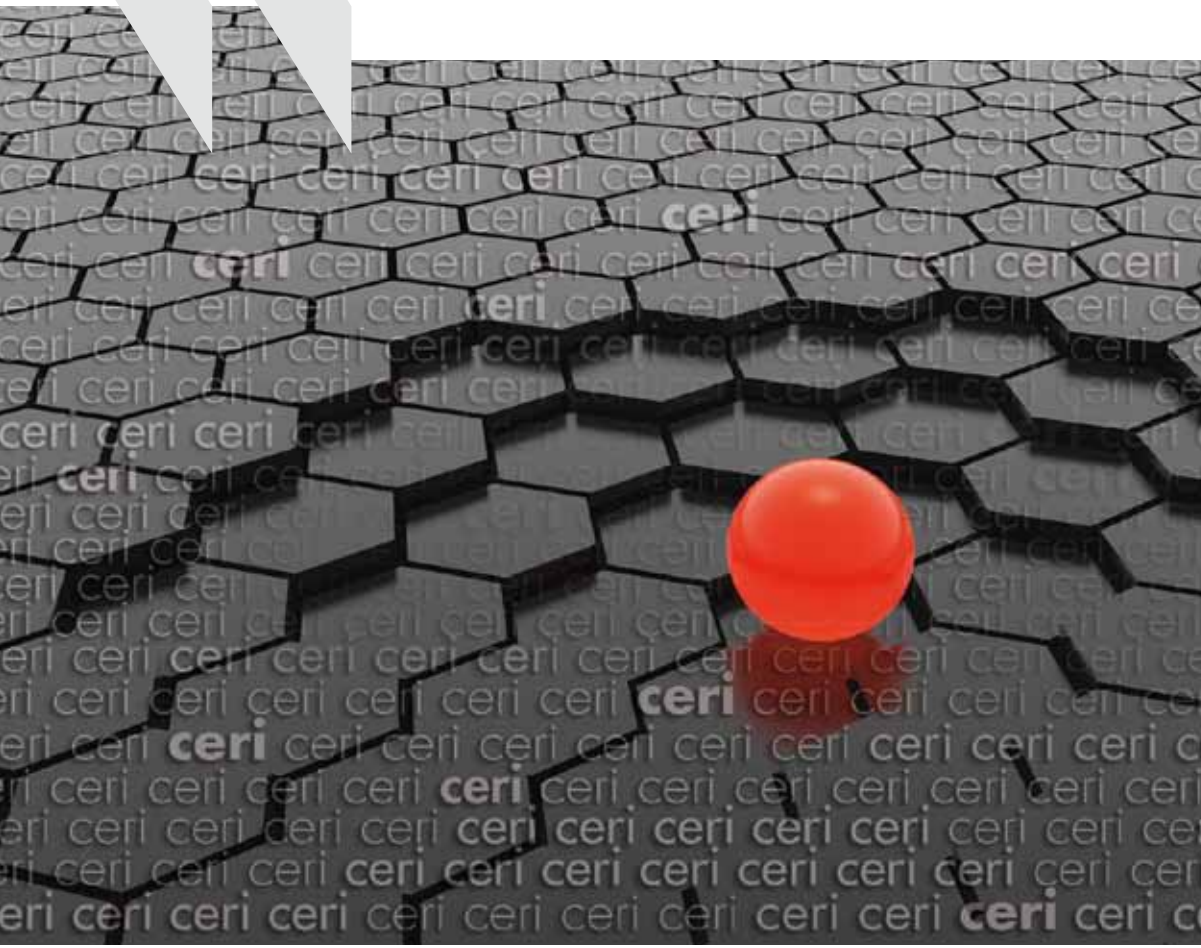
Beyond Textbooks

DIGITAL LEARNING RESOURCES AS SYSTEMIC INNOVATION IN THE NORDIC COUNTRIES



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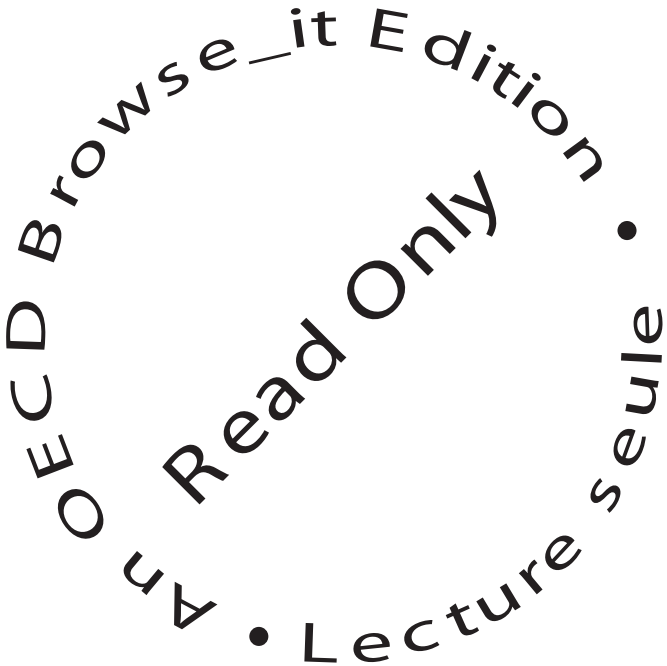

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DIGITAL LEARNING RESOURCES AS SYSTEMIC INNOVATION IN THE NORDIC COUNTRIES

CENTRE FOR EDUCATIONAL RESEARCH AND INNOVATION

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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Foreword

Until recently, policies designed to promote the use of information and communication technologies (ICT) in school education in OECD countries have mostly focused on investment in infrastructure, equipment and in-service teacher training. Today these policies place more emphasis on the added value that ICT can bring to teaching and learning, and as a result, pay more attention to the development and publication of digital learning resources (DLR), *i.e.* any digital or digitised resource actually used for learning by teachers or students. To this end, a number of government subsidised programmes, repositories and networks have been set up. In addition, private initiatives have been trying to address a potential market niche, either by supplementing existing printed materials or by generating new services intended to provide useful digital contents or applications to teachers. Further, there is a noticeable trend towards teacher-generated digital learning materials, offered either as open or paying resources both to the teaching community and to parents and pupils themselves. However, until now little effort has been devoted to mapping the resulting landscape, even if governments show a growing interest in the actual level of use of such resources by teachers, how these resources contribute to the quality of learning, how they can improve learning outcomes and what the factors may encourage or prevent the dissemination of ICT-based educational innovations.

This book focuses on the processes surrounding the development and use of digital learning resources by following a systemic innovation approach – an original analytical framework developed at the OECD Centre for Educational Research and Development (CERI) and successfully applied to the analysis of innovation processes in other education sectors. Most recently, this analytical framework was applied to vocational education and training in the recent OECD report entitled *Working Out Change: Systemic Innovation in Vocational Education and Training.* Systemic innovation can be defined as any kind of dynamic system-wide change that is intended to add value to educational processes and outcomes. Systemic innovation aims to improve the operation of systems, their overall performance, and the perceived satisfaction of the main stakeholders with the system as a whole. The approach taken here in the analysis of DLRs as systemic innovations involves the

comparative investigation of how Nordic countries go about initiating innovations related to their design, promotion and use in schools, the processes involved, the knowledge base which is drawn on, and the procedures and criteria for assessing progress and outcomes.

A wide range of issues is analysed in this book, including learning content, software tools for producing, using and distributing content, and implementation resources such as copyright licenses. The empirical analysis drew on a selection of cases of innovative development and use of digital learning resources in the five Nordic countries (Denmark, Finland, Iceland, Norway and Sweden). The cases were analysed following a systemic innovation perspective, *i.e.* by examining their development through and impact on the system as a whole. The role of stakeholders, including government, publishers and teaching professionals, and the use of knowledge were important aspects of the process that informed the analysis and lead to the policy implications offered.

In many respects this project benefits from the previous CERI work done in the domain of open digital learning resources in higher education, which has been published as *Giving Knowledge for Free: Open Education Resources in Higher Education* in 2007. In fact, this project was conceptualised and drafted as a spin-off of the open digital learning resources project, thanks to fruitful exchanges among Yngve Wallin (Swedish Knowledge Foundation), Oystein Johannessen (Norwegian Ministry of Education and Research), and Jan Hylén, Francesc Pedró and Tom Schuller from CERI. The project manager was Francesc Pedró. Katerina Ananiadou (CERI) and Jan Hylén (Metamatrix, Sweden) were responsible for liaising with countries and organising the country visits. The final report was drafted by Jan Hylén, except for Chapter 8 which was written by Beñat Bilbao-Osorio and Francesc Pedró. The final text incorporated comments from a large group of international experts and country representatives as well as CERI analysts. The whole project and this publication benefited from the assistance of Ashley Allen-Sinclair, Therese Walsh and Cassandra Davis.

ACKNOWLEDGEMENTS

This project would not have been possible without the support of the participating countries: Denmark, Finland, Iceland, Norway and Sweden. The work was supported by a grant from the Swedish Knowledge Foundation. The Secretariat also wants to acknowledge the contribution of the following individuals in organising the study visits from the country side: Leo Højsholt-Poulsen (Denmark), Peppi Taalas (Finland), Allyson Macdonald (Iceland), Lisbeth Pedersen (Norway), and Peter Karlberg (Sweden).

The authors would like to thank the project's external experts for their invaluable contribution to the empirical and analytical phases of this study: Jim Ayre, Multimedia Ventures Europe Ltd., Roger Blamire, European Schoolnet, Belgium; Magnus Boman, Royal Institute of Technology, Sweden; Ferry de Rijcke, Ministry of Economic Affairs, Netherlands; Gavin Dykes, Becta, UK; Ólafur H. Jóhannsson, University of Iceland, Iceland; Allan Luke, Queensland University of Technology, Australia; Matti Sinko, Helsinki University of Technology, Finland; Mike Trucano, World Bank; UK; Sang Min Whang, Yonsei University, South Korea; and Christian Wang, University College Lillebælt, Denmark.

Last but not least, the team would like to thank the participants from all OECD countries who shared their thoughts and time in the study visit interviews to make them such a success.

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Executive Summary

This report reviews the vast range of opportunities that digital learning resources (DLRs) offer for systemic innovation in the school systems of the Nordic countries and how these opportunities are used by the main stakeholders.

The definition of DLR used throughout this report is quite broad as it corresponds to *any digital resource that is actually used by teachers and learners for the purpose of learning.* Accordingly, the report refers not only to learning resources that have been designed from the very outset as digital materials, such as a website dedicated to learners of English as a foreign language, but also other resources that have been digitised, such the *Encyclopaedia Britannica*. It covers as well digital tools and resources that can be used in any learning context, for example, an e-learning platform or any kind of Internet browser. Next, and perhaps most importantly, it covers resources produced by commercial publishers, governments or public agencies, such as public broadcasting companies or libraries. Last but not least, this report considers the users themselves and teachers in particular.

Context

This report forms part of the OECD studies on systemic innovation, including the OECD's work on systemic innovation in vocational education and training (VET; OECD [2009]), and it relates closely to CERI's work in the New Millennium Learners project. In addition, the research presented here draws on lessons learned from previous CERI work on Open Educational Resources (OER) in the broader field of digital learning resources (OECD, 2007a) and aims to provide a better understanding of the process of systemic innovation regarding ICT in schools. The lessons learned from the OER project include the strength of bottom-up innovations and the importance of new business models emerging around free content and new copyright licenses, such as Creative Commons, for the education sector. It is still not known how these recent developments impact on the production and use of DLRs in schools. Further, the pressing need for countries to take

a global view on the production and distribution of DLRs – be they for commercial or non-commercial resources – is further highlighted by the fact that institutions and individuals sometimes give away their knowledge for free as OERs.

Objectives

The broad aim of this report is to review and evaluate the process of systemic innovation in policy making and in both public and private initiatives designed to promote the development, distribution and use of DLRs for the school sector. In so doing, it brings together evidence on:

1. how countries go about initiating ICT-based educational innovations related to DLRs, the players and processes involved, the knowledge base drawn on, and the procedures and criteria for assessing progress and outcomes;
2. the factors influencing the success of policies aimed at promoting ICT-based educational innovations, particularly those related to the production, distribution and use of DLRs, including user involvement in the production process and new actors such as the gaming industry and media companies;
3. user-driven innovations related to DLRs carried out by teachers and researchers, such as innovative production and use of DLRs, and how the educational system responds to such innovations.

Accordingly, instead of focusing on discrete institutional innovations, this report seeks to provide a better understanding of how the process of systemic innovation works best in relation to DLRs. The innovation process, as defined in the analytical framework of this study, is composed of several phases, including initiation, implementation, scale up, monitoring and evaluation. Each of these phases has been examined in this study together with other factors that influence the development of the innovation process such as governance and financing.

Methodology

The methodological approach consisted of two different strands, analytical and empirical. Building on the parallel OECD project on systemic innovation in VET (OECD [2009]), an analytical framework was developed by the Secretariat. The analytical framework has also made use of the three classic pillars of ICT policy development: *(i)* investments in ICT infrastructure in schools, *(ii)* investments in in-service training or competence development for teachers (and head teachers), and *(iii)* investments in development of content and software tools. The empirical strand was based on a series of

country visits and case studies. Rather than aiming for full country reviews, the project built on case studies developed by a team of international experts on the basis of a Country Background Report. Each country proposed cases, which were discussed with the experts and chosen by the Secretariat.

Main findings

DLRs as innovations from a systemic perspective

Examining the different stages of the innovation process has been of central importance throughout this study. Particularly important is the role of different stakeholders and how actors have used different kinds of knowledge during the various phases of innovation: initiation, implementation, scale-up, monitoring and evaluation. These phases can best be understood as a cycle whereby knowledge is generated to inform future innovations. In this respect, the main findings are succinctly presented below:

- The *initiation phase* can be understood by asking who initiated the innovation: was it driven by governments or government agencies, commercial players or users? When looking at target groups for the innovations and funding models used to foster DLRs, no salient pattern arises. Despite a few exceptions, it is clear that the use of academic research has so far been very limited – independently of who initiated the innovation. This is also the case when looking at the involvement of stakeholders in the initiation phase. Almost all innovations in the study have been initiated on the basis of "build it and they will come".
- The *implementation phase* regarding DLR innovations is somewhat different compared to innovations in other fields of education, including VET. The DLR cases in this study cover a range of resources, from new websites built by a small group of teachers and government-initiated campaigns, to novel ways of organising market offers from companies. In none of the cases examined in this study are organisational issues – *e.g.* reorganisation of the workflow or workload of a large number of people – of any significance. Since no pilots were implemented before launching an innovation, incremental developments are common.
- The idea of *scaling up* a digital innovation is also different when compared to that of most educational innovations. Given that a host organisation has enough bandwidth and server capacity, any number of users can take advantage of a digital artefact at the same time. The marginal cost for one new user is close to zero. When talking about the production process as, for example, in a publishing house, scaling up might also mean increasing the number of DLRs they offer.

Issues related to scale-up concern funding models associated with the sustainability of an innovation. Many have experienced that the ease with which one can initiate or start up a project contrasts with the difficulties of keeping it going in the long run. Sustainability is a key issue, particularly for user-generated innovations. There are several cases of development projects, started with government or EU funding, that turned into commercial companies – sometimes intentionally so by the innovators, sometimes rather unwillingly. A few of the user-generated innovations have created ways for companies to capitalise on user-created content (UCC) as a way to scale its activities (OECD, 2007b). So far, publishers and government-initiated innovations have had difficulties in doing likewise.

- *Monitoring and evaluation* is needed to know whether an innovation is successful or not. Monitoring can be done on a day-to-day basis or in a more systematic and formal way, thus blurring the line in regard to evaluations. When talking about web-based innovations, there are two customary methods for gathering information on who is using the innovation, how much, when and what they think about it:
  - web statistics: this is an easy way to check the number of downloads or users, how much time they spend with the DLRs, which parts most people use, which web pages they spend most time on, etc.; and
  - views from users, usually gathered unsystematically;

Both are used by all actors together with different kind of monitoring. Publishers and other commercial actors complement these methods with market statistics. Overall, formal evaluations are rare.

Looking at the *knowledge base* used in the innovation process, a distinction is made between tacit and explicit knowledge. Tacit knowledge is knowledge in our heads and hands, not yet formulated or sometimes not even possible to formulate. Explicit knowledge is codified or documented as academic research, professional knowledge (in this case, professionals might be teachers, civil servants or publishers), knowledge documented in government papers, or statistical or administrative data such as user statistics. There are at least three areas of knowledge involved in this study: *(i)* knowledge about educational issues, *(ii)* knowledge about ICT, and *(iii)* market knowledge (not to mention a publisher's expertise in developing learning materials). In the mid-1990s when the government portals – the earliest DLRs studied in the report – were initiated, the knowledge base was weak. A minimal effort has been made by private or public players to strengthen this knowledge base and to make use of existing research and knowledge in the innovation process. This is still the case.

There is a wide range of *stakeholders* involved in the process of innovation in education: from students, parents, teachers, researchers, schools, local and even regional educational authorities to private companies, not-for-profit organisations and charitable foundations; from public innovation agencies and government (including state and sub-state agencies) to international organisations. The stakeholders are coming from different viewpoints and have different incentives to innovate or promote innovation, for example, to increase effective teaching and learning; to cut costs; to identify best practices for improving the system; and, in the case of commercial players, to create new markets.

The issue of incentives touches upon why innovations are initiated. Regarding this issue our knowledge is limited to rather general statements. Most government-initiated innovations come as a result of either a long-term interest to improve the educational system – which is most common – or an immediate need to respond to criticism. Innovations initiated by the private sector are assumed to be initiated by the profit motive, which, of course, does not *per se* exclude a desire to improve the system. A second reason might be a need to innovate in order to meet the competition coming from other players although no immediate revenue can be expected from the innovation. The motive for individual teachers or researchers seems to be a mix of a need to improve their working conditions and the aspiration to further their professional development.

Drivers and barriers to DLR innovation

An important part of this work has been to identify which factors drive, and which hinder, DLR innovations. It is vital to the development of successful policies for innovation that such factors be identified and, if possible and desirable, replicated in strategies that governments can employ to support innovation.

Before going into the question of drivers and barriers, some more general factors creating favourable conditions enabling innovation should be described. The first and most important enabler is the political interest in the issue at hand or a sense of urgency. In the mid-1990s, policy makers in the Nordic countries were convinced that ICT would radically change their societies, demanding a lot from schools; hence, new DLRs were needed. Later, the interest decreased in some countries while remaining strong in others. A hindrance to DLR innovation related to political interest seems to be the absence of a governmental DLR policy. This does not necessarily imply money. Seed money seems to drive the production of DLRs, but policy messages regarding the importance of ICT in education are also relevant.

The motivation among teachers to use existing DLRs in their teaching seems also to be linked to the existence of governmental interest and a national policy. In a benchmarking study on the access and use of ICT in European schools, a model is used to generate a typology according to the "propensity to the use of computers and Internet by teachers in classroom situations in schools". The model, which was first developed by Viherä and Nurmela (2001), takes account of three main categories of preconditions which necessary for a teacher to make use of computers and the Internet in the teaching process in classrooms, computer labs, etc. – namely *access*, *competence* and *motivation*. Data from the Empirica study (2006) shows that motivation among teachers to use ICT is a higher in Denmark and Norway, countries with an active ICT policy.

Another enabler is whether digital competence is considered as a key skill for the future or not. Some of the Nordic countries have taken up the European Commission and European Parliament declaration of digital competence as a key competence for the future (European Commission, 2006). Others have not. Lack of political interest in digital competencies seems to affect teachers' motivation to use DLRs.

A third potentially important factor for facilitating the development of DLRs is the concept of a national digital commons, *i.e.* the opportunity for individuals and companies to share publicly funded digital resources for non-commercial purposes for free.

Concerning drivers for innovation, a key driver is an effective demand from schools, *i.e.* that schools are actually prepared to buy DLRs at market price. Reciprocally, lack of effective demand is a barrier, which in turn means that the short-term economic incentives for publishers to introduce innovative DLRs are small. Another barrier for publishers might arise should DLRs be perceived as "cannibalizing" a profitable textbook market. If this happens (and it is not clear whether or not it will), there is again a disincentive for publishers with commercially successful printed textbooks to innovate.

In an emerging market with limited resources, such as the DLRs market, public funding is an important driver. This could take the form of public tenders to publishers and project funding for groups of teachers and researchers. So far, the idea of school vouchers for purchasing DLRs has not been tested in the Nordic countries.

A driver of a more specific kind also appears in the Nordic countries. When the political interest for ICT in education faded in some countries, "intrapreneurs", or inside entrepreneurs, appeared in the form of senior officials with an abiding interest in, and willingness to promote, the use of ICT and DLRs in schools. Furthermore, it is vital to provide schools and teachers with information about what kind of DLRs are available. Such repositories of

information could be complemented with methods to facilitate the evaluation of DLRs for teachers, such as user-feedback, tracking number of downloads, etc.

The barrier related to this driver is the weak knowledge base regarding DLR innovations in terms of needs, use and possible innovations. In addition, there a lack of an overview of on-going developments could be stifling co-operation and further innovation, and, moreover, the absence of involvement from stakeholders could potentially lead to misinterpretation of user needs and resistance to use the DLRs.

Conclusions and policy implications

Governments can take different roles in innovation – from creating favourable conditions to fostering leaders of innovation. Depending on their needs and political interest in promoting innovation in the area in question, governments often take several roles at the same time. The following policy recommendations address these potential roles. In order to create enabling conditions for innovation in the area of DLRs, governments could:

- establish a coherent vision on digital competence;
- make publicly funded information freely available for commercial and other use;
- join up innovation initiatives making researchers and entrepreneurs visible;
- establish a forum for dialogue between innovators and stakeholders; and
- support the building up of a formal knowledge base for DLR development.

Furthermore, it is recommended that governments federate existing educational portals to provide support services of different kinds in order to facilitate access to, and use of, DLRs (both commercial and non-commercial) and promote DLR design and use *via* teacher training institutions for both initial and in-service training. Local authorities could increase teacher awareness of the existence of Open Educational Resources and invest in training on fair use for teachers and school managers as well as to promote the use of DLRs for teacher professional development.

It is further recommended that governments supplement seed money with development funds and transition funding for development projects, and promote co-operation between public and private players for DLR development.

To become leaders of innovation, governments should consider the relative circumstances of their country when deciding whether to introduce new DLRs or support the initiatives of others. In the case of smaller countries, for example, it may be preferable to identify DLRs at the European level and to focus more on localisation. Governments should also consider strategically rethinking their role in relation to communities from an "engagement", rather than a "delivery", point of view.

One final conclusion in regard to innovation in education to be drawn is that technology makes the conditions for DLR innovation different from many other fields in education. It seems clear that successful ICT-based innovations spread fast and that small, user-generated innovation may have a systemic impact. Moreover, it is difficult to plan for scaling-up ICT-based innovations since it is the end-users who ultimately determine the success of innovations.

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Chapter 1

Introduction

The chapter introduces the background of the study, its aims and the methodology used. It also provides a description of the content of the rest of the report.

Background

Change is taking place at various speeds in different parts of education systems in most OECD countries, with varying drivers and degrees of premeditation. Although the management of change within complex systems is a key challenge to educational policy makers, the dynamics of innovation in education are not fully understood. So far, not much comparative analytical attention has been devoted to the policies related to educational innovation, the knowledge base on which they draw, and their effectiveness. Policies aimed at the promotion of the use of ICT in school education in OECD countries have focused, until recently, mostly on investment in infrastructures, equipment and in-service training. Today these policies emphasise more the added value that ICT can bring about to teaching and learning and have, therefore, paid a lot of attention to the development and publication of digital learning resources. To this end, a number of government subsidised programs, repositories and networks have been set up. However, there is a growing interest in the actual level of use of such resources by teachers and students, how these resources contribute to the quality of learning and on the factors that can eventually prevent the dissemination of ICT-based educational innovations. This report focuses on digital learning resources (DLRs), understood in the broadest sense of any kind of digital resources used for learning in schools.There are strong technical, economic and legal drivers pushing for an increased use of ICT and user created content in society in general. These include improved, less costly, and more user friendly information technology infrastructure (such as broadband), hardware and software. Content is cheaper and easier to produce and costs can be further reduced by

sharing. New economic models are emerging around the distribution of free content. Legal drivers are new licensing schemes facilitating sharing and reuse of content. Social drivers include increased willingness to participate in online activities and share self-made content. It is still unknown how these developments impact on the production and use of digital learning resources in schools.

This report forms part of a series of OECD studies on systemic innovation. The research will draw on lessons learned from previous CERI work on Open Educational Resources (OER) in the broader field of digital learning resources (OECD, 2007), and provide a better understanding of the process of innovation regarding ICT in schools. The lessons learned from the OER project include the strength of bottom-up innovations, the importance for the education sector of new business models emerging around free content and building partly on new copyright licenses, such as Creative Commons. It also highlighted the need for countries to take a global view on the production and distribution of digital learning resources, be it commercial or non-commercial resources. It also feeds into the Secretariat's work on innovation, particularly the work on systemic innovation in vocational education and training (VET). A common analytical framework has been used in the VET project and the study in question, which will be elaborated in Chapters 2 and 4. Finally it relates closely to CERI work within the New Millennium Learner project.

The aim of the study

The broad aim of this activity is to review and evaluate the process of innovation involved in policies and public as well as private initiatives designed to promote the development, distribution and use of digital learning resources for the school sector. In so doing, the activity has brought together evidence of:

- how countries[1] go about initiating ICT-based educational innovations related to DLRs, the players and processes involved, the knowledge base which is drawn on, and the procedures and criteria for assessing progress and outcomes;
- factors that influence the success of policies aimed at promoting ICT-based educational innovations, particularly those related to the production, distribution and use of DLRs including user involvement in the production process and new actors such as the gaming industry and media companies;
- user-driven innovations related to DLRs, carried out by students and teachers, such as innovative production and use of DLRs, and how the educational system responds to such innovations.

Accordingly, instead of focusing on discrete institutional innovations, this activity aims at a better understanding of how the process of systemic innovation works best in relation to DLRs.

The examination of the different stages of the innovation process is of central importance to this study. Particularly important is the role of different stakeholders and how actors have used different kinds of knowledge during the five phases of innovation: initiation, implementation, scale-up, monitoring and evaluation. An important part of the analytical work is to identify which factors drive and hinder DLR innovations. It is vital to the development of successful policies for innovation that such factors can be identified and in the case of drivers, if possible, replicated in strategies for governments to support innovation.

The introduction and use of ICT and DLRs can be regarded as one of the main innovation sources for education. It has the potential to bring about substantial system wide benefits in terms of improving the quality of the teaching and learning processes and the educational performance of students. As elaborated in Chapter 3, there are several reasons for promoting ICT in schools, such as the fact that it is a way of developing human capital and contributing to economic growth, and to advance education reform.

Methodology

Five countries participated in the project: Denmark, Finland, Iceland, Norway and Sweden, all from the Nordic region. The project used the traditional OECD review process, consisting of four parts:

- A background report written by the country itself, which describes the state of the issue;
- A review visit to each of the countries by a team of experts;
- A country case report written by OECD on the basis of the findings during the visit;
- A comparative report, synthesising the findings from the country reports, making comparisons between countries and drawing general conclusions.

The reports from the different phases of the project can be downloaded from the DLRs project website.[2]

This activity focused on the school sector (primary and secondary education) of the participating countries. It had two different strands, analytical and empirical. The *analytical strand* is intended to provide a framework for the subsequent empirical work. Building on the parallel OECD project on systemic

innovation in VET, an analytical framework was developed by the Secretariat (see OECD, 2009). The framework has also made use of the three classic pillars of ICT policy development: investments in ICT infrastructure in schools; investments in in-service training or competence development for teachers (and school heads); and investments in development of content and software tools. The analytical framework has also provided the basis for the guidelines to the Country Background Reports which constituted the basis for the empirical strand. The *empirical strand* was based around a series of country visits and case studies. Rather than aiming for full country reviews, the project built on case studies developed by a team of experts on the basis of a Country Background Report.

Each of the participating countries put together a Country Background Report which formed an important input to the review teams. This report was intended to:

- Provide a description of the national context related to the development and use of digital learning resources in the schools sector (DLRs);
- Describe the national strategy for digital learning resources; and
- Provide an analysis of the key factors influencing the development and use of DLRs and an analysis of key policy concerns in a number of specific areas.

All background reports were prepared within a common framework in order to facilitate the comparative analysis and to maximise the opportunities for countries to learn from each other. The country background reports are available at the OECD DLRs project website (*www.oecd.org/edu/systemicinnovation/dlr*).

Country visits and case studies

Eleven experts on ICT in education and DLRs were involved in the project – four from the Nordic countries, four from other European countries, and three from outside Europe (Australia, South Korea and the United States [the World Bank]). The experts carried out three-day visits to each of the participating countries, accompanied by members of the CERI Secretariat. The team visiting each country consisted of one expert from the Nordic countries, one from another European country, and one from another continent (see Table 1.1). During the visits the teams met with a range of stakeholders involved in the different case studies, including teachers, students, national agencies, ministries of education as well as representatives of municipalities and the publishing industry, selected by the national coordinator for detailed study in the context of the project. Individual country reports based on evidence gathered during the visits are available at the OECD DLRs project website.

Table 1.1. **Expert teams and visited countries in the DLRs project**

Date	Country	Experts	Secretariat staff
June 2-4	Denmark	Ferry de Rijcke, Ministry of Economic Affairs , Netherlands; Matti Sinko, Helsinki University of Technology, Finland; Sang Min Whang, Yonsei University, South Korea	Katerina Ananiadou, Beñat Bilbao-Osorio, Jan Hylén, Francesc Pedró
June 5-9	Norway	Ferry de Rijcke, Ministry of Economic Affairs, Netherlands; Christian Wang, University College Lillebaelt, Denmark; Sang Min Whang, Yonsei University, South Korea	Katerina Ananiadou, Beñat Bilbao-Osorio, Jan Hylén, Francesc Pedró
June 10-12	Sweden	Gavin Dykes, Becta UK; Christian Wang, University College Lillebaelt, Denmark; Sang Min Whang, Yonsei University, South Korea;	Katerina Ananiadou, Jan Hylén
September 1-3	Iceland	Roger Blamire, European Schoolnet, Belgium; Magnus Boman, Royal Institute of Technology, Sweden; Mike Trucano, World Bank, United States	Jan Hylén, Francesc Pedró
September 15-17	Finland	Jim Ayre, Multimedia Ventures Europe Ltd., United Kingdom; Ólafur H. Jóhannsson, University of Iceland, Iceland; Allan Luke, Queensland University of Technology, Australia	Katerina Ananiadou, Jan Hylén

The case studies formed an important part of the DLRs project. They complement the Country Background Report by giving more in-depth knowledge on systemic innovation. Case studies can be used for many reasons. One way to differentiate between different kinds of uses is to distinguish between exploratory, explanatory and descriptive case studies (Tellis, 1997a, 1997b). Since the cases have been used to illustrate or describe leading innovations in each country, they are used in an *exploratory* rather than descriptive or explanatory way.

The cases of interest to this project have been cases of innovative policies or strategies regarding DLRs that are perceived to have improved the operation of the educational system, its performance in a specific country and/or the satisfaction of the main stakeholders.

The cases are intended to:

- illustrate leading innovations in the country rather than to be representative of the everyday use of learning resources;
- focus on schools but also draw on examples from other sectors (such as in-service training for teachers and adult learning);
- highlight key questions on the process of development and use of the resource, and

- illustrate the knowledge or evidence base used in the development process or in the implementation of different ways of using the resource.

It was agreed that all countries should have their national educational portal as one of the cases as this would provide a common framework that would facilitate comparisons. Countries also tried to provide at least one case of a commercial and one user-driven DLR (see Table 1.2). A more detailed description of the cases studied during the course of the project can be found in Appendix A.

The structure of the report

The report contains eight chapters. Chapter 2 explains the analytical framework together with definitions of the concept and terms used. It also explains how this work is related to other relevant research. Chapter 3deals with ICT polices in the Nordic countries. It describes commonalities and differences between ICT policies in the five countries and analyses the role of DLRs in national strategies and programmes. Chapters 4 to 6 focus on the analyses of the cases of DLR innovations reviewed by the experts. They are clustered according to how they were initiated – by governments or government agencies as in the case of EMU (DK1), EDU.fi (FI1), the National Gateway (IC1), NCEM (IC2), Utdanning.no (NO1), You Decide (NO2), IT for Teachers (SE1) and the Course Hub (SE2) in Chapter 4; commercial players such as Subscriptions (DK2), the School Web (Aschehoug (NO2), and by educational broadcasters such as Areena (FI3) and Abitreenit (FI4) and the Media Bank (SE3) in Chapter 5; or by users, *i.e.* teams of teachers and researchers such as Peda.net (FI2), the School Web (IC3), Language Studio (IC4), Katla Web (IC5), IceKids (IC6), and Lektion.se (SE4) in Chapter 6. The analytical framework is used to examine the different phases of innovation – initiation, implementation, scale-up, and monitoring and evaluation. The role of stakeholders and the use of a knowledge base in the innovation process are examined. Finally, each chapter looks at the drivers and barriers for innovation related to from where they are initiated, and policy recommendations are discussed. Chapter 7 discusses the conclusions and recommendations that might be drawn from the previous chapters particularly focusing on how innovations can be promoted and barriers overcome. Finally, Chapter 8 describes how to improve the knowledge base for future DLR strategies. It presents a conceptual framework for a system of indicators on benchmarking DLRs and assesses the impact of DLRs. It also proposes a research agenda. The report ends with two appendices, one describing the cases of DLR innovation in detail and another explaining the national policies and programmes for ICT in schools in the five countries.

Table 1.2. **Cases studied in the DLRs project**

Country	Name	Category	Designation
Denmark	EMU	The national educational portal	DK 1
	Subscription to DLRs	Publishers selling packages of DLRs to schools	DK 2
	ITIF (ICT in the public school)	Government programme with, among other things, resources for private companies to produce DLRs	DK 3
Finland	Virtual School including EDU.fi	The national educational portal	FI 1
	Peda.net	Research and development project providing schools with DLRs	FI 2
	Areena	The digital extension of YLE´s televised production	FI 3
	Abitreenit	Practice material for students preparing themselves for the matriculation examination produced by YLE	FI 4
Iceland	The Educational Gateway	The national educational portal	IC 1
	The National Centre for Educational Materials (NCEM)	National agency developing and translating educational materials which are sold to schools.	IC 2
	The School Web	Private company developing and selling DLRs to schools	IC 3
	The Language Studio	Support and materials for distance teaching of Nordic languages, supported by the city of Reykjavik	IC 4
	The Katla Web	Support and materials for teaching Icelandic as a second language. School subscriptions	IC 5
	IceKids	Provide Icelandic families living abroad with learning resources for studying their mother tongue. Family subscription	IC 6
Norway	Utdanning.no	The national educational portal	NO 1
	Achehough	Publishing house with a web portal called Lokus.no	NO 2
	You Decide	Government initiated campaign on the subject of data protection	NO 3
Sweden	IT for Teachers	The national educational portal	SE 1
	The Course Hub	Government initiated DLRs repository for teachers	SE 2
	UR and the Media Bank	Radio and TV clips from the education broadcasting company	SE 3
	Lektion.se	Teacher created website and community for teachers exchange of lesson plans	SE 4

Notes

1. "Countries" are not necessarily to be equated with "governments". In this field in particular, a range of significant agents and institutions are likely to be involved, with much of the impetus coming from the bottom up.

2. See *www.oecd.org/edu/systemicinnovation/dlr*.

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Chapter 2

Systemic Innovation and ICT in Education

This chapter presents the analytical framework of the study together with concepts of "digital learning resources" and "innovation" that are being used in the report. It gives a short history of the development of DLRs and explains how this work is related to other related areas of research. Furthermore, it looks at possible factors influencing the use of DLRs introducing an analytical model which looks at access to, competence in and motivation to use DLRs. Finally it describes the closely related phenomenon of open educational resources.

The concept of digital learning resources

The study used the term "digital learning resources" (DLRs). It was not the aim of the study to do any innovative work related to the definition of the concept. The purpose of this section is only to state the position of the DLRs project regarding some of the issues that arose in the discussion on the concept of digital learning resources.

This study has only considered learning resources that are *digital* – either digitised or digital by origin. By a digital resource we understand a resource that exists in binary numeric form, as in digital audio or digital images, videos or software.

The concept of "learning resources" will be used to describe all kinds of content that can promote a learning process – be it a textbook, an atlas, lab equipment, software, a video clip or a web page. In addition some case studies (*e.g.* Peda.net in Finland) focused on innovative tools for creating and manipulating content. By using the term "learning resource", it is emphasized that learning always starts and ends with a person, not a textbook or a DLR.

The term "learning resources" is intentionally chosen to distinguish the artefacts in question from traditional textbooks. DLRs are different from traditional printed textbooks in many ways. One obvious difference is that digital learning resources can be *interactive*, *i.e.* to accept and respond to input from the user. It is the interactivity which makes simulations and hypertextuality[1] possible. (Bundsgaard, 2005) A DLR constructed as simulation might have a the simulator that represents a physical environment in which it is safe and inexpensive to conduct explorations and experiments otherwise impossible, difficult, too expensive or dangerous. One further dissimilarity is that visual presentations in digital format can be made not only as still pictures but also as short video sequences or animations with or without sound. Sometimes the learning resource can be made into a representation of the subject matter, like a business or a farm. A digital learning resource is both an artefact and a semiotic tool with a bigger potential than traditional textbooks. One further difference is that most textbooks have been developed within the framework of the public school system with its specific traditions and rules regarding what kind of goals students should reach. Many digital learning resources have a different story – not necessarily emanating from the needs of the school system but from a broader commercial market or social or research context.

The term "learning resources", which has been used throughout this activity, should be distinguished from "teaching materials" or "learning materials." Drotner (2006b) argues that the term "learning resources" makes it clear that it is the goal and the context of learning which decides if something is a learning resource or not, not the technology in itself – be it a printed book or a laboratory. The term "learning materials" puts emphasis on the tools and underemphasises the process of learning.

A "learning resource" can refer either to any resource used by teachers and students for the purpose of learning, or to resources particularly designed to be used in learning settings. It is both a strength and a weakness of the former definition that it is very general – it can refer to anything from a stone or a feather, to Encyclopaedia Britannica or advanced databases, as long as it is used for learning. The second definition is more limited and hence easier to use. But it excludes resources like online newspaper articles, most computer games, and applications such as Google Earth and Gapminder. Although ease of use is important, the broader definition has been used throughout this study, not least because the project is about innovations and innovative practices, it would be unwise to restrict the artefacts studied on formal grounds. To conclude, this means that by "digital learning resources" we understand *any digital resource that is actually used by teachers and learners for the purpose of learning.*

The history of different types of DLRs

It is difficult to accurately track the historical rollout of DLRs across the OECD countries in a variety of technical formats, not least because of the large number of platforms and standards that have preceded the current focus on SCORM[2] compliant Learning Objects and other types of online learning resources that can be rendered and viewed in a web browser.

The 1960s interest in pedagogical systems such as Computer Aided Instruction (CAI), Computer Assisted Learning (CAL) and Computer Based Training (CBT) led, in some countries, to early national development programmes and strategies primarily for higher education. Later on we have seen Computer Supported Collaborative Learning (CSCL), learning games, epistemic games, and interactive assistants. This interest in pedagogical systems was followed by an explosion of educational, training and consumer multimedia formats, or memory media, in the early 1980s: Laserdisc/videodisc (in analogue rather than digital format), HyperCard stacks, CD-ROM, CD-ROM XA, MMCD, CD-i, DVI, DVD. The trigger for this expansion was the introduction of personal computers (PC) in the early 1980s. In due course, this stupendous jargon of acronyms for rapidly changing multimedia formats produced both innovative educational titles as well as a new hybrid, "edutainment"[3] resources, before the bursting of the Internet bubble in early 2000, the demise of many leading-edge multimedia educational developers and a move towards online content delivery.

In this context, it is important to recognise that the current policy response to DLRs has not developed in a vacuum and that the legacy of previous policy and funding decisions may colour how policy makers, commercial vendors and learning professionals now respond to new opportunities to invest in web-based educational content. It should also be remembered that learning platforms or learning management systems are an important link in many educational systems in the chain of getting digital content to schools. The platform vendors are important players that have contributed to digital change but were not chosen as cases in this study.

The field of research and development in DLRs is still emerging and rapidly changing. There is so far no consensus as to how to categorize different types of DLRs. One classification, usually called the Computer Assisted Instruction (CAI) classification, takes its starting point from Bloom's hierarchical taxonomy of intellectual abilities and skills. (Kausar, Choudhry and Gujjar, 2008) It starts with DLRs for drill and practice, moving on to tutorials, instructional games and simulations to problem-solving software and discovery-environments. In contrast to the CAI taxonomy, there are classifications that are more theoretically neutral. The European Schoolnet (EUN) has developed a classification with, at the moment, has 32 values for "Resource Types" such as application, assessment, course, exploration,

glossary, lesson plan, role play, simulation, wiki, etc. The purpose of this classification is to support the exchange of information about all types of online DLRs between partners of the EUN Learning Resource Exchange service for schools.[4] Since the principle is that it should be possible to find the same resource using different search terms, the items in the classification are not mutually exclusive. Instead the aim is to describe different types of DLRs as exhaustively as possible without any value judgement.

Related areas of research

Computers in education are generally used in two broad contexts: (1) to provide computer skills' training, and (2) to provide Technology Enhanced Learning (TEL), in which computers are used to enhance teaching and learning methods, strategies and activities throughout the curriculum. While there is a clear case for the use of ICT for enhancing the computer skills of students, the role of TEL is more controversial. (Machin *et al.,* 2006) There is neither a strong, well-developed theoretical case, nor much empirical evidence, supporting the expected benefits accruing from the use of ICT in schools, as different studies report mixed results (Kirkpatrick and Cuban, 1998).

The empirical evidence on the issue has not been conclusive so far. On the one hand, studies carried out for example by Becta (2002) and Machin *et al.* (2006) find a positive effect of the use of ICT on educational attainment, and on the other hand, the research carried out by Fuchs and Woessman (2004), Leuven *et al.* (2004) or Goolsbee and Guryan (2002) find no positive correlation between the use of ICT and educational results, once other factors, such as school characteristics or socio-economic background, are taken into account. There is insufficient evidence to affirm either the superiority or inferiority of ICT-rich methodologies. This would seem to be the outcome of the two systematic reviews of literature conducted recently, which conclude that "in general and despite thousands of studies about the impact of ICT use on student attainment, it is difficult to measure and remains reasonably open to debate" (Infodev, 2005), and also that "some studies reveal a positive correlation between the availability of computer access or computer use and attainment, others reveal a negative correlation, whilst yet others indicate no correlation whatsoever between the two" (Kozma, 2006).

However, an in-depth analysis of the available knowledge base shows that school attainment only improves if certain pedagogical conditions are met. This is the conclusion reached by Kulik (2003), who used the measurement of the effects found by eight different meta-analyses covering 335 studies before 1990 and 61 controlled experiments whose outcomes were published after 1990. Most of the studies carried out in the 1990s concluded that stimulation

programmes have positive effects when used to enhance reading and writing capabilities and that, albeit less frequently, they have a clearly positive effect on mathematics and natural and social sciences. Indeed, "simply giving students' greater access to both computers and internet resources often results in improved writing skills". The performance of primary school pupils using tutorials to improve their writing, improved significantly in this field. Even very young primary school pupils using computers to write their own stories ended up improving their marks in reading. In short, there is a positive correlation between the frequent use of word processors and improved writing-related capabilities.

While teachers' attitudes towards and competencies in using ICT have been widely recognised as a key factor (Williams *et al.,* 1998) and important public investments have aimed at enhancing these competencies, much less attention has been paid to the DLRs market. Although many big private publishing companies have entered the market of developing DLRs and have acknowledged their potential, such as the Norwegian publishing house Aschehoug (NO3), until recently they have regarded this market as unattractive as significant profits have not been made and the return on investments has not been attractive. A possible explanation for this may lie in the role that private publishers play in the development of materials for schools, either in analogue or digital form. Commercial publishers have traditionally played a key role in developing and distributing printed learning material. However, when it comes to DLRs, they seem to find that the market may not be ready to take up this type of resource yet, mainly due to the lack of infrastructure, teacher's skills or cultural factors. Therefore, they may lack the necessary incentive to develop this kind of materials. At the same time, the lack of readily available DLRs of sufficient quality can also affect the motivation and attitudes of teachers towards DLRs and ICT more broadly, and the need to invest in ICT infrastructures. On the whole, a vicious circle is created when the lack of significant teacher demand is a disincentive to publishers, which in turn affects negatively the demand and where all the parties are closely intertwined among themselves.

In addition to private publishers, students and teachers have also started producing DLRs by themselves, partly following the rationale which is successfully inspiring the production and use of open educational materials in higher education. (OECD, 2007) There are several examples of teacher production of DLRs in this study, such as Katla Web (IC5) and Lektion.se (SE4). There has been a shift in the use of DLRs from the situation where teachers and students were only users of learning material, to one where they are also producing material that they exchange among themselves. The material of these "user-producer" or "prosumer" teachers and students is increasingly important and will continue to be so as Web 2.0 applications become common-place. However, until now, there has been not much research on this

issue. To this end, Chapter 8 develops a conceptual framework for a system of benchmarking indicators that could strengthen the knowledge on the development, use and effects of DLRs.

DLRs can play a key role in the learning processes of the students. Content is an important building block in several models of learning. A didactical model developed by Norwegian researchers at the end of the 1970s identifies key prerequisites for learning, of which content is one. Content can influence teaching methods and the choice of learning resources. (Bjørndal and Lieberg, 1978) The need for methodological diversity, which is embedded in most curricula, points to the need for a rich and diverse supply of learning resources ranging from traditional textbooks to DLRs. The need for innovation is imminent. Textbooks build on a long tradition of pedagogy and insights into how good learning resources are designed and packaged, but it is fair to assume that the potential for innovation in the field of textbooks is more or less exhausted. That is not the case when it comes to innovation in DLRs. Given the importance of learning resources for the learning processes of each student, education systems must innovate in this field. This requires a thorough understanding of what constitutes high quality learning resources as well as research-based evidence of how DLRs influences learning outcomes and learning strategies.

Research on teaching materials and learning resources

The concept of DLRs touches upon at least two areas of research, each of them too broad and rich to be adequately discussed here. One is research on learning materials or textbooks. The other is research on Learning Objects.

There exists no commonly accepted definition or internationally accepted term on what to call the texts, media and other tools used in schools for learning. Different terms have been used by different researchers and at different times, such as "instructional materials", "textbooks", "educational texts", or "educational media." Drotner (2006a) argues that this shows that educational materials are often defined in relation to different technologies and that the emphasis on the different technologies changes over time.

Building on Svensson (2000), Drotner also argues that research on textbooks can be divided into three categories: one process oriented, one user oriented and one production oriented (Drotner, 2006b). The process oriented research emphasises the socio-economic conditions for production, distribution and marketing. The user oriented strand looks at the actual use of textbooks and other learning tools in the classroom and makes use of pedagogical theory and didactic methodology. Production oriented research, emphasises text analyses and uses rhetoric theory, semiotic analyses and quantitative text analyses with a comparative perspective.

Drotner (2006b) concludes that the digitization of learning materials increases the exchange and interaction between different ways of expression and use. This relates also to educational materials. In turn the digitization of learning materials raises new challenges for the research which has to be able to study, analyze and understand these new complexities. Future research needs to connect the three traditions to each other in a more global approach. The research perspective needs to be widened to include also how learning resources are designed, both by professionals and users, and the interplay between individual resources and with specific learning situations. Finally, pedagogical and didactical research needs to be considered in the context of media research and ICT research to be able to meet the new challenges posed by the developments in DLRs.

As regards Learning Objects (LOs), there is a vast literature, not least regarding what constitutes a LO. Haughey and Muirhead (2005) note that "[a]lthough there is an extensive and ever-growing literature about learning objects the clarity of the term continues to be elusive". The discussion might be described as shifting from a deductive to an inductive approach, *i.e.* from attempts to first agree on what kinds of materials should be developed and used, to an approach where the materials and pedagogy actually used is more in focus (Wiley, 2003). McCormick (2003) uses a definition worked out by the standardisation organisation IEEE, where LOs are defined as: "any entity, digital or non-digital, that can be used or re-used or referenced during technology supported learning". As noted both by Haughey and Muirhead (2005) and McCormick, most of the research on LOs has focused on higher education. They equally agree that one of the greatest challenges for LOs – the size of the objects or what should be included in them – looks different from a school perspective in relation to higher education. Haughey and Muirhead conclude that the "challenge is 'not too large' or 'not too small' but 'just right'", which, of course, is a statement that does not give much guidance.

An aspect of the size of the object concerns the extent to which pedagogical principles should be included in the object. McCormick (2003) discusses some of the conflicts that occur between different interest groups in school settings and learning theorists working with LOs, related to the use, production, and possibility to search and find resources. He contends that there are some trade-offs to be aware of: when LOs try to contain a specific pedagogy, usually one that draws upon contemporary ideas of learning, they are usually not sophisticated enough to satisfy learning theorists. Where LOs are put together in pedagogically sound ways, they move away from the focus on the LOs themselves to the planning tool used by teachers to assemble them or the learning environment within which they are used. Thus, it might be better, McCormick argues, to keep the pedagogy out and advocates "the development of LOs with sophisticated, high quality media representation of content, around which teachers build learning activities and assessments".

Wiley's (2003) discussion on the reusability of LOs ends up in what he calls "the reusability paradox": "while the most decontextualized learning objects are reusable in the greatest number of learning contexts, they are also the most expensive and difficult for instructional designers to reuse" (Wiley, 2003).

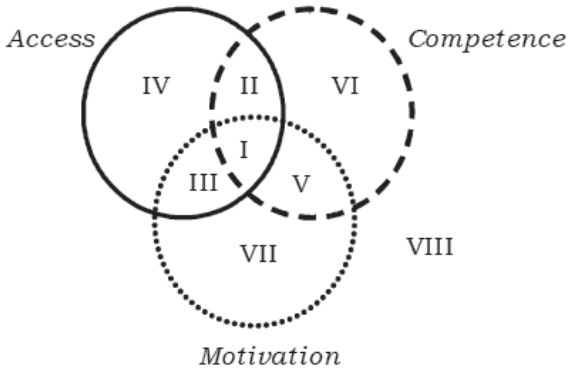
The study in question does not need to take any stand on these issues. It is, however, necessary to be aware of the ongoing discussions and debates regarding LOs and the fact that much of the discussion is of relevance to the production, use and evaluation of DLRs. But it should be noted that the advancement of new and better DLRs could benefit from a cross-fertilisation between the research on learning materials and Learning Objects.

Possible factors influencing DLRs use

In a benchmarking study on the access to and use of ICT in European schools (Empirica, 2006) a model called ACM (Access, Competence, Motivation) was used to generate a typology of the propensity towards the use of computers and the Internet by teachers in classroom situations in schools. The model, which was first developed by Viherä and Nurmela (2001), takes account of the three main categories of preconditions which need to be given for teachers and learners to make use of computers and the internet.

The model focuses on access (to computers and the Internet at school), competence (in using computer software and the Internet, and applying it for teaching purposes) and motivation (gauged through the attitude that using computers in classrooms result in significant learning benefits). Each of the factors *access* (marked IV in Figure 2.1), *competence* (VI) and *motivation*

Figure 2.1. **The access, competence and motivation (ACM) model**



Source: Empirica (2006) based on Viherä and Nurmela (2001).

(VII) to use ICT in education are necessary conditions for the use of DLRs. Taken together (I) they form sufficient conditions for the use of ICT.

The ACM model is of relevance to the present study. *Access* to DLRs is of course important. Good access to high quality DLRs could be expected to increase their use in schools. But access to ready-made DLRs is not vital – teachers and students could develop their own materials. This means that access is important but not vital. *Competence* to evaluate which DLR to use at a certain moment, as well as competence to actually apply it, is another central factor for the actual use of DLRs. Although many countries have invested heavily in developing teachers' ICT skills, very little of these resources seem to have been devoted to the training of the use and evaluation of DLRs. This, in turn, might affect the *motivation* for using DLRs. Without knowledge about when and how to use DLRs, levels of motivation for actually applying such tools in the classroom could be expected to be low.

Some of the empirical data from previous research, such as the Empirica 2006 study, Ramboll Management (2006) and Dahler, Drotner and Duus (2009) are useful when drawing conclusions regarding the situation in respective countries. Results from Ramboll (2006) looking at drivers and barriers for ICT to have "an impact on education" supports the ACM model. According to Ramboll (2006) the most important driver to increased use is easy accessible ICT equipment. The most important barriers are related to lack of sufficient ICT skills, and knowledge of pedagogical opportunities among teachers, which in the ACM model is equated with competence. The ACM model will be used later on in the report.

Open Educational Resources

A topical phenomenon is the emergence of open educational resources (OER) in higher education (OECD, 2007). Higher education is facing a number of challenges: globalization, an aging society, growing competition between higher educational institutions both nationally and internationally, and rapid technological development. OER is itself one of these challenges, but may also be a sound strategy for individual institutions to meet them. The trend towards sharing software programmes (open source software) and research outcomes (open access publishing) is already so strong that it is generally thought of as a movement. It is now complemented by the trend towards sharing learning resources – the open educational resources' movement.

The report's title, *Giving Knowledge for Free*, reveals the potential implications of the OER movement. OER is not only a fascinating technological and sociological development and potentially a major educational tool. It accelerates the convergence of formal and informal learning, and of

educational and broader cultural activities. It raises basic philosophical issues to do with the nature of ownership, with the validation of knowledge and with concepts such as altruism and collective goods. It reaches into issues of property and its distribution across the globe. It offers the prospect of a radically new approach to the sharing of knowledge, at a time when effective use of knowledge is seen more and more as the key to economic success, for both individuals and nations. How paradoxical this may turn out to be, and the forms it will eventually take are entirely unforeseeable. The report offers some preliminary handles for understanding the issues raised.

OER projects can expand access to learning for everyone, but most of all for non-traditional groups of students, and thus widen participation in education. They can be an efficient way of promoting lifelong learning, both for individuals and for government, and can bridge the gap between non-formal, informal and formal learning.

This phenomenon has so far mostly affected tertiary education but can be expected to have a growing importance also for schools. Given the definition of OER as "digitised materials offered freely and openly for educators, students and self-learners to use and reuse for teaching, learning and research", OER should be viewed as a subset of DLRs. All OER are DLRs, but all DLRs are not OER. That means that some DLRs are not open – *i.e.* due to commercial or other reasons teachers and learners cannot use them for free, or repurpose or reuse them.

Defining the concept of innovation

Innovation is an elusive concept often used as a straightforward synonym to "reform" or "change". In a paper by Mulgan and Albury (2003) on innovation in the public sector, innovation is defined simply as "new ideas that work", further elaborated as: "the creation and implementation of new processes, products, services and methods of delivery which result in significant improvements in outcomes, efficiency, effectiveness or quality". A commonsense approach suggests that any change in an educational context that brings about an improvement, or the subjective perception of such an improvement, counts as an innovation. This is particularly clear when the change results from the experience of a problem or of a failure.

In this respect, innovation could be differentiated from "reform" or "change" as these terms do not necessarily imply the application of something new to the social setting of reference, nor do they imply that the change relates to the application of improved ideas or knowledge. But a problem with the incorporation of the idea of an improvement is that, in practice, it is difficult to know when something reflects progress over the existing situation: sometimes this can only be known in the long term, and often it is not known

at all – as there is a significant lack of evidence and systematic assessment of what changes improve the previous situation. Thus, sometimes innovation is referred to as a synonym of "novelty" – *i.e.* ideas or knowledge that had not been implemented before in a given context – without incorporating the need for the concept to refer to an improvement. Under this definition of the concept it would be possible to talk about "unsuccessful innovations" (Fullan, 1982); (see also Carless, 1997; Kinser, 2005).

In a paper to the European Commission, Shapiro *et al.* (Shapiro, 2007) describe innovations as phenomena with the following characteristics:

- An innovation is a tangible product, process, or procedure, within an organisation or across organizations.
- An innovation must be new to the particular organisational setting within which it is introduced, though not necessarily new to the one introducing it.
- An innovation must not be a routine change.
- An innovation must produce measurable benefits.
- An innovation must be public in its effect.

But as already noted, the criterion that an innovation must bring about improvements might be too strong, since it might be impossible to know or at least present evidence of this progress. Also the last two criteria would limit the range of possible phenomena to be studied.

In a literature review on innovation in education OECD (2009) conclude that the extent to which something is new to a given social context is crucial to identify innovation. A reform, on the other hand, could be, for example, an official legitimisation of well-known teaching practices. Thus, in line with the already stated pragmatic perspective, the concept of innovation that will be used in this study is deliberately open: *innovation is change that is introduced with the aim of improving the operation of education systems, their performance, the perceived satisfaction of the main stakeholders, or all of them at the same time.* The use of such an open definition allows for diversity.

Understanding how to foster innovation in education is essential for education systems to adjust to social and economic changes, and also to perform better in terms of achievement, equity and efficiency. Three points can be made regarding how education systems generally deal with innovation. First, education in general and schools in particular are conventionally poor at knowledge management – too much educational practice takes place in isolation (individual teachers in individual classrooms) using old-fashioned methods in bureaucratic organisations. Educators tend to be reluctant to exploit the key motors of innovation that many other sectors do, such as research

knowledge, networks among professionals and organisations, modular reorganisation of basic structures, and using technology to create opportunities to work differently. Second, educational research and development is not given the support it needs to effect change and promote innovation. Despite the role of knowledge based innovation in education, education systems typically have low levels of investment in educational research; low levels of research capacity; and weak links between research, policy, educational practice and innovation. Third, much of educational decision-making is preoccupied by the short term, with disincentives to innovate. A balance needs to be found between responding to the immediate and working towards the strategic and long term. We need a shared conceptual framework and particularly an operational definition of what innovation in education is, and how innovation can be identified. It is often said that what makes innovation substantially different from change is that change brings novelty, but innovation adds value.

One way of identifying innovations is to look at whom it is targeting – not only talk about innovation, but innovation for whom? In this study the following set of stakeholders have been identified as relevant in the innovation process in education: students, parents/homes, teachers, researchers, schools, local educational authorities, private companies and for-profit private entities, non-for-profit organisations and charitable foundations, public innovation agencies, government (including state and sub-state agencies), and international organisations. Table 2.1 identifies the incentives for innovating and promoting innovation for each group of stakeholders.

The following are three examples of innovations from the field of ICT in education. The first is the use of wikis and blogs in education. These are tools freely available on the Internet that any teacher can use together with his or her students. Wikis and blogs make it possible for students not only to consume texts but to be producers themselves. They learn to work in teams and to solve problems together. The teacher can synchronously or asynchronously follow the production process to see who is doing what and where the students need support. Overall student performance in writing, team work and problem solving is enhanced. A second example is the use of interactive whiteboards in classrooms. These tools can either be used in a traditional way – keeping the teacher in front of the class, and only animating the role of the teacher as a "sage on the stage" – or with the students as active participants in the learning process and the teacher as the "guide at the side". A third example is school use of learning platforms for improving communication with parents. With a web-based platform, parents can easily follow the work of the students, see what homework is due and give comments to the teachers. In a context characterized by poor communication between homes and school such a system could be an innovation. In all these examples, new technology is used with the intention of improving the performance of the system and/or the perceived satisfaction of the users and ultimately student

learning outcomes, and thus they fit into the definition given above. These examples also highlight the fact that it is *the use* of an artefact or a process that marks an innovation, not the idea itself. An idea, however revolutionary, that is never put in action or use, is not an innovation.

Levels of innovation – systemic or discrete

The *systemic* analysis of innovation, as distinct from the analyses of discrete innovations, involves the comparative investigation of how education systems or sectors go about initiating innovation, the processes involved, the knowledge base which is drawn on, and the procedures and criteria for assessing progress and outcomes. Following this approach, a systemic analysis of innovation in education will pay attention to:

- The conceptualisation of innovation
- The dynamics of innovation from a knowledge management perspective
- Innovation drivers and their context
- Innovation indicators
- Knowledge dissemination

In order to capture the process underlying innovation, systemic analysis focuses on how innovation develops dynamically; that is, how it is adapted to context and how that context is then shaped by the innovation. To do this a systemic approach should look particularly at sustainability and scaling up, *i.e.* built-in capacity building such that the innovation could be sustained and refined over time, and wide adoption in institutional process or development (also a marker of success).

Incremental or radical innovation

Innovations could be classified according to the level of change associated with them. One frequently used classification is the one that categorizes innovations as being:

- *Incremental*, *i.e.* associated with minor changes to existing services or processes; or
- *Radical*, *i.e.* associated with the introduction of new services or ways of "doing things" in relation to processes or service delivery.

Christensen and Horn (2008) propose a similar dichotomy. They distinguish between *sustaining* and *disruptive* innovations. A sustaining innovation helps a leading company or player to stay ahead. A disruptive innovation is

not a breakthrough improvement. Instead it "extend[s] its benefits to people who, for one reason or another, are unable to consume the original product, so called non-consumers. Disruptive innovations tend to be simpler and more affordable than existing products." The question put forward by Christensen and Horn is whether the new Internet applications that emphasise collaboration, interaction, and user generated content, (sometimes described as Web 2.0), constitute a disruptive innovation for the publishing industry. Some publishers try, so far not very successfully, to apply Web 2.0 applications to their existing business model. Instead, all sorts of much cheaper and simpler user generated content, sometimes in the form of OER, find a growing number of users. But since this question is at the heart of this study, it would be premature to adopt a definition to innovation already giving some of the answer.

Although an implicit assumption is often that systemic innovations are developed at the top by governments, as in the case of the national educational portals EMU (DK1), EDU.fi (FI1), the National Gateway (IC1), Utdanning.no (NO1), and IT for Teachers (SE1), the Course Hub (SE2) and the government initiated campaign You Decide (NO2). But this is not always true. The empirical evidence in this study reveals instances of system wide innovations initiated by commercial players, such as publishers or media companies (Subscriptions (DK2), Areena (FI3), Abitreenit (FI4) The School Web (IC3) and Aschehoug (NO2), or directly by users such as in Lektion.se (SE4), referred to here as being user-generated. Innovations starting as small scale user-generated innovations that become popular grow in terms of the number of products and services it offers and people running it, might transform at a later stage. They might be picked up by a government agency or commercialised and turned into commercial companies. Several examples of this development can be found among the cases in this study – small groups of teachers or researchers who initiated a project that later became a successful company with system-wide impact.

Generally seen as something intrinsically good, governments seek to promote the emergence of innovations and to support and scale-up existing ones. In so doing, the most commonly used methods are:

- Becoming leaders of innovations themselves;
- Setting up specific programmes mainly aimed at supporting innovations by funding them or providing external support, including support from industry;
- Setting up agencies, usually with a strong involvement both of the research and the professional community, which can provide an array of programmes, but work also as brokerage agents;
- Creating or encouraging the creation of networks of innovators, be these institutions, groups of educators or individuals.

Much remains to be known about the effects and effectiveness of these policies and their behaviour in different system configurations. Evaluating them is difficult and one cannot, for example, simply count the increase of the number of ongoing educational innovations. However, policies should be evaluated in terms of their ability to support innovations and to decide, making use of available evidence, when a particular innovation is worth scaling up, and how to successfully achieve this.

The dimensions of innovation

The definition of innovation used in this report is that innovation is change that is introduced with the aim of improving the operation of education systems, their performance, the perceived satisfaction of the main stakeholders, or all of them at the same time. Given this definition but also insights and knowledge developed in the course of this study and the parallel OECD work on systemic innovation in vocational education and training (see OECD, 2009), three dimensions has been considered important to better understand systemic innovation in education: *(a)* contextual factors, *(b)* type of initiative or output, and *(c)* the process of innovation. Each of these three dimensions consists of several variables.

Contextual factors include the following:

- The groups of stakeholders that make purchasing decisions regarding DLRs, *e.g.* individual teachers, schools, municipalities or government agencies;
- The existence of a governmental clearing house for approval of teaching materials before they are allowed to be used by schools;
- The balance between privately and governmentally produced DLRs; whether the DLRs "market" is dominated by government agencies or by private companies?
- The kind of funding mechanisms, including revenues from sales, that exist for DLRs producers – be it publishers, media companies, individual teachers or others;
- Access to publicly owned digital materials – do private actors have access to publicly owned digital resources, for commercial or non-commercial use?

In the case of the Nordic countries, all decisions regarding purchase and use of materials are taken at local level, although they differ in terms of whether the decisions are taken by the municipality or by individual teachers. None of these five countries has a clearing house or similar institution at the moment.

The **types of initiatives or output** of innovation include:

- Different forms of digital materials and services – stand alone DLR productions (textbooks in digital format); repositories or collections of learning objects; other online services like tools and services linked to a Learning Management System; or packages of content and services including updates.
- Different types of DLR content – content can be more or less related to particular curriculum elements, *i.e.* specifically curriculum related (materials for teaching algebra) or more general, as dictionaries, atlases or tools for making online school magazines.
- Different target groups – students only, teachers only, or both. Other possible target groups could be school managers or families.

Most of the DLRs cases in this study represent products, a website or other kind of digital materials, that can be used by teachers and students. Some are organisations, like the Icelandic NCEM (IC2), and some are processes, such as the Danish case Subscriptions (DK2).

Finally the **process of innovation** includes issues such as:

- Who initiated the innovation – was it done by the government or a government agency (top-down), by an established publishing company (top-down) or by individual teachers and/or researchers (bottom-up)?
- Why was the process initiated – as a response to or a part of a government policy, to make a profit or to fill a need felt by the initiators themselves?
- To what degree were stakeholders involved – stakeholders could be teachers, researchers, textbook authors, government agencies or content owners (*i.e.* museums)?
- When producing the DLR, what kind of knowledge base was used – explicit knowledge or tacit? If explicit, in what ways was it used – *e.g.* for fixing a problem, or to legitimize the change introduced?

It is assumed that the three dimensions – context, output and process – are interrelated, although it is not entirely clear how the interaction works. This strand of work is still at an early stage and needs to be further refined and tested. Given also the limited empirical data available in this study, the relations are too complex to be exactly described. As is evident in the examples above, there are a number of variables for each dimension and too few empirical cases in this study for all the variables. In addition, this study was exploratory rather than explanatory in its scope and aims, which was also one of the reasons for using a case study methodology.

The innovation process

The examination of the different stages of the innovation process is of central importance to the study in question. Particularly important is the role of different stakeholders and how actors have used different kinds of knowledge during the five aspects or stages of innovation: initiation, implementation, scale-up, monitoring and evaluation. These phases need to be understood as a cycle where knowledge is generated to inform future innovations.

Initiation

The initiation phase can be looked at by who initiated the innovation, for example, whether it was driven by users, commercial players or governments. Other issues of interest are the target group the innovation was aiming at and the funding model was used. Finally, the degree of involvement of other stakeholders in the initiation phase is a question of interest.

Implementation

The implementation phase will be very different regarding innovations in DLRs compared to innovations in other fields of the education sector. The DLRs cases in this study cover a range of resources, from new websites built by a small group of teachers (such as the Katla Web [IC5], and Lekton.se [SE4]) and government initiated campaigns (such as You Decide [NO4], to novel ways of organising market offers from companies (Subscription [DK2]. In none of the cases in this study would one expect that organisational issues, *e.g.* reorganisation of the workflow or workload of a large number of people, to be of significance.

Scale-up

The idea of scaling up a digital innovation is somewhat different from other innovations. Given that the host organisation has enough bandwidth and server capacity, any number of users can use a digital artefact at the same time. The marginal cost for one new user is close to zero, leaving aside the marketing cost. When talking about the production process, as for a publishing house, scaling up might also mean enlarging the number of DLRs they offer. Another aspect of scaling-up the use of DLRs is that digital artefacts often are what in economic theory are called "non-rival", *i.e.* they can be enjoyed without reducing the enjoyment of others. It is not only the case that such resources are available to anyone despite their use by others; in some cases the resource becomes more valuable as more people use it. This is the case for open source software, the telephone, e-mail and other networked services, not all of them available for free, a phenomenon described as

Metcalf's law.[5] The more people use a service, the more valuable it is to have access to it.

Issues related to scale-up concern funding models associated with the sustainability of an innovation. Many have experienced that it is much easier to initiate or start-up a project than finding a way to keep it going in the long run. Sustainability is a key issue. On top of the funding models, issues regarding the involvement of users and stakeholders in the scaling-up process will be considered.

Monitoring and evaluation

Monitoring and evaluation are essential stages in the innovation cycle in order to establish to what extent particular initiatives are successful or not. Monitoring can be done on a day-to-day basis or, more seldom, in a more systematic and formal fashion, thus blurring the line towards evaluations. When talking about web-based innovations, two methods are customary in gathering information on who is using it, how much, when and what they think about it:

- web statistics – the number of downloads or users, how long they spend with the DLRs, which parts most people use, which web pages they spend most time on; and
- user feedback, often gathered in a non-systematic way.

These methods can be combined and complemented with market statistics and different kind of evaluations. No evidence have been found suggesting that the funding mechanism affect the monitoring and/or evaluation, or whether the monitoring and/or evaluation models depend on the target group and which role, if any, stakeholders have been given in this process.

The knowledge base

Looking at the types of knowledge used in the design and implementation phase, a first distinction can be made between tacit and explicit knowledge. Tacit knowledge is knowledge in our heads and hands, not yet formulated or sometimes not even possible to formulate. Explicit knowledge is codified or documented. Explicit knowledge may take different forms: academic knowledge or research, professional knowledge (professionals in this case might be teachers, civil servants or publishers), knowledge documented in government papers, statistical or administrative data, such as user statistics.

Stakeholders in innovation

Questions regarding the extent and types of involvement of different stakeholders are particularly important in the analysis of systemic innovation. As outlined in OECD (2009), there is a wide range of stakeholders involved in the process of innovation in education, and each set of stakeholders has different incentives to begin innovation (see Table 2.1).

Table 2.1. **Stakeholders in innovation**

Stakeholder	Incentives to innovate/promote innovation
Students	Increased effectiveness of teaching and learning
Parents/homes	Increased effectiveness of teaching and learning
Teachers	Professional development, increased effectiveness in teaching and learning
Researchers	Increased effectiveness in teaching and learning, availability of innovation funding
Schools	Availability of innovation funding
Local educational authorities	Increased effectiveness of teaching and learning, opportunities of cutting costs
Private companies and for-profit private entities	Creation of new markets (e.g. for ICT companies). Development of free DLRs as marketing or as part of Corporate Social Responsibility programs. Involvement in the delivery of education (e.g. Edison Schools), and related aspects (as all components of the educational offering – instructional staff, courses, libraries and services for students – may be acquired from an outside source [Natriello, 2005]).
Non-for-profit organisations and charitable foundations	Identification of best practice to improve the system. Involvement in the delivery of education and related aspects (e.g. the Knowledge Foundation in Sweden). Development of free DLRs as
Public innovation agencies	Identification of best practice to improve the system. Increased role in policy making
Government (including state and sub-state agencies)	Positive public perception of change. Increased effectiveness in education policy
International organisations	Identification of best practice to improve the system. Increased role in policy making

Source: Adapted from OECD (2009a).

The issue of incentives touches upon why innovations are initiated. As regards why the innovations studied in this report were initiated, our knowledge is limited to rather general statements. Most government initiated innovations come as a result of either a long-term interest in improving the educational system – which is most common – or an immediate need to respond to criticism (as in the Norwegian case of Utdanning.no [NO]). Innovations initiated by the private sector are assumed to be initiated by reason of profit, which of course does not *per se* exclude a will to improve the system. A second reason, which might also include the educational

broadcasters, could be a need to innovate in order to meet the competition coming from other players, although no immediate revenue can be expected from the innovation. The motive for individual teachers or researchers seems to be a mix of a need to improve their working conditions and an aspiration to develop professionally.

Stakeholders could generally be expected to support innovation, but not monolithically. There might very well be resistance to change, *e.g.* by private publishers not wanting their existing business model to be threatened; by politicians not wanting to do away with well-established practices such as the use of one-size-fits-all textbooks; or by teachers not wanting their traditional way of teaching challenged. Commitment to change from stakeholders is a key factor determining the effectiveness of the implementation of innovations in the education system. Most important is probably the acceptance of the innovation from teachers.

Table 2.2 highlights the kinds of issues that arise when looking at the context, output and role of stakeholders during the different stages of the innovation process. The questions in the boxes will guide the further exploration of the cases of innovation investigated in this study.

Table 2.2. **The process of innovation related to context, output and stakeholders**

	Process of innovation			
	Initiation	Implementation	Scale-up	Monitoring and evaluation
Context **Funding**	Who initiated the innovation and with what kind of funding?	Who funded the implementation?	Who is running and scaling-up the innovation and with what kind of funding?	Does the funding mechanism affect the model of monitoring and evaluation?
Context **Target groups**	Who initiated the innovation and towards which target group?	Are there different knowledge bases used by different target groups?	Is it easier to scale-up when targeting particular user groups?	Does the monitoring and/or evaluation depend on the target group?
Output **Radical or incremental DLRs**	Who initiated the innovation and was it radical or incremental?	Are there different knowledge bases used if the innovation is radical or incremental?	Is it easier to scale-up if the innovation is radical or incremental?	Will the monitoring and evaluation look different if the innovation is radical compared to incremental?
Role of stakeholders	Any role for stakeholders in the initiation process?	Any use of stakeholders' knowledge?	Any role for stakeholders in the scale-up process?	Any role for stakeholders in the evaluation process?

Characteristics of policies on ICT in education

One of the most debated potential sources of systemic innovation in education is ICT. The introduction and use of ICT and DLRs can be regarded as one of the main innovation sources for education. It has the potential to bring about substantial system wide benefits in terms of improving the quality of the teaching and learning processes and the educational performance of students. However, policies aimed at the promotion of the use of ICT in school education in OECD countries have, until recently, mostly focused on investment in infrastructures, equipment and in-service training. Today these policies emphasise more the added value that ICT can bring about to teaching and learning and have, therefore, paid much attention to the development and distribution of DLRs.

Although government initiated strategies or programmes are not a necessary condition for the introduction and use of ICT and later DLRs in school education, there seem to be a fairly close connection. The study coordinator of the three SITES studies[6] Robert Kozma (2008) concludes that important things regarding ICT in education can happen without a national policy. "But without the guidance of national policies and the resources of corollary programs, it is less likely that individual school and classroom innovations will be sustained. Nor is it likely individual effects will accrue across the country to have an overall impact on the educational system." When comparing national ICT policy statements, he identifies four alternative, somewhat related, rationales for justifying investments in educational ICT:

- To support economic growth mainly by developing the human capital and increasing the productivity of the workforce;
- To promote social development by sharing knowledge, fostering cultural creativity, increasing democratic participation, improving access to government services, and enhancing social cohesion;
- To advance education reform, *i.e.* major curriculum revisions, shifts in pedagogy or assessment changes. Kozma (2008) also states that "The kinds of education reforms that have been associated with the introduction of ICT include curriculum reforms that emphasize high levels of understanding of key concepts within subject areas and the ability to apply these concepts to solve complex, real-world problems. Other curriculum reforms emphasize what are sometimes called "21st century skills", qualities that prepare students for the knowledge economy, such as creativity, information management, communication, collaboration, and the ability to direct one's own work and learning".

- To support educational management and accountability, with an emphasis on computer-based testing and the use of digital data and management systems.

These rationales are not mutually exclusive and there are many examples of countries using two or more of them at the same time.

When looking at the operational policies to realize the visions, Kozma identifies five components that often appear alone or in combination:

1. Infrastructure development, *i.e.* provision and budget allocation for technical resources;
2. Teacher training;
3. Technical support, both in terms of assistance to teachers to connect hardware and software and also to help them integrate ICT across all curricula subjects;
4. Pedagogical and curricular change, often to include information skills, thinking skills and creativity, communication skills, knowledge application skills, self-management skills, and character development;
5. Content development. Some countries, because of the uniqueness of their curricula or special considerations of culture and language, find a need to emphasize the development of digital content as part of their operational policy.

In his comparison of the ICT initiatives in the educational sector of Germany, Korea and the United States, Lee (2003) concludes that the spectrum of implementation of core policies in the three countries is similar, although the implementation approaches differ among these countries. It tends to proceed from infrastructure building through use of digital contents and resources, student/teacher use of technology, and teacher training. He proposes that this has to do with ICT development phases worldwide and that it might also mean that there is similarity of perspectives on ICT implementation, regardless of cultural differences.

Conclusions

To sum up, this study has adopted a wide definition of DLRs, considering any digital resource used by teachers and learners for the purpose of learning as a DLR. The study uses a model of innovation consisting of five phases: initiation, implementation, scale-up, monitoring and evaluation. Two important cross-cutting variables in the process are the use of the knowledge base and the role of stakeholders. One aim of the study was the identification of factors that drive and hinder DLR innovations, as this is considered crucial to

the development of successful policies for innovation. To the extent that such factors can be identified and replicated, possible strategies for governments to support innovation in different phases of the innovation process will be explored and discussed.

DLRs used on a large scale in schools are considered as instances of systemic innovation. One important related question is why education systems should be innovative. As discussed above, this has to do with the possibility of the system to contribute to a societal need of innovation, which is seen not only as a key factor to economic growth but also to social welfare. Innovation relies heavily on the creation of basic knowledge, through both education and science. A well-performing education system facilitates the adoption and diffusion of innovation, by providing human capital for innovation and by innovation within education and training. A well-performing education system also means a system in tune with changes taking place in society, such as globalisation, technological developments and the growing amount of informal learning that is taking place outside the education system. It also needs to take into account individual needs of children, differences in learning styles, special needs, and special talents. To meet these demands our education systems need to improve their operations, performance, and the satisfaction among the stakeholders – hence to innovate.

Notes

1. Wikipedia defines "hypertext" as text, displayed on a computer, with references (hyperlinks) to other text that the reader can immediately follow, usually by a mouse click or key-press sequence (see *http://en.wikipedia.org/wiki/Hypertext).*
2. According to Wikipedia SCORM is the acronym for Sharable Content Object Reference Model which is a collection of standards and specifications for web-based e-learning. It defines communications between client side content and a host system called the run-time environment, commonly a function of a learning management system (see *http://en.wikipedia.org/wiki/SCORM*).
3. Wikipedia defines "edutainment" (also educational entertainment or entertainment-education) as a form of entertainment designed to educate as well as to amuse (see *http://en.wikipedia.org/wiki/Edutainment*).
4. *http://lreforschools.eun.org.*
5. See *http://en.wikipedia.org/wiki/Metcalfe%27s_Law.*
6. *http://www.sitesm2.org/sitesm2_project.html*.

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Chapter 3

ICT Policy in the Nordic Countries

This chapter will describe some similarities and dissimilarities among the five Nordic countries which are of relevance to the production and use of DLRs. Viewed from the outside, the region looks homogeneous, consisting of rather small well-off countries with large tax-funded public sectors. The education systems are decentralised and well equipped in terms of ICT broadband and number of students per computer. There is a long-standing tradition of cooperation in the region, symbolised and supported for long by the Nordic Council of Ministers. On the other hand there are a number of differences, making the region an interesting starting point for comparisons.

The Nordic context

The Nordic region's five nation-states share much common history as well as correspondences in their respective societies, such as political systems.[1] They are characterised by similar structures of their societies and

Table 3.1. **Key data on population, income and broadband subscribers in the Nordic countries**

	Population (in hundred thousands)	National income per capita (USD)	Broadband subscribers per 100 inhabitants[1]
Denmark	5 500	35 704	36.7
Finland	5 300	32 906	30.7
Iceland	301	32 662	32.3
Norway	4 700	51 915	33.4
Sweden	9 200	35 023	32.3

1. OECD average: 21.3.

Source: OECD (2008), OECD Factbook 2008.

cultural traits. This is a result not only of similar environmental realities but also to some extent of a shared history. The Nordic countries share similar traits in the policies implemented in the post-war period, especially in the socio-economic area. Table 3.1 shows that all five countries are small in terms of population, highly technically developed and wealthy.

As Table 3.2 shows, the number of broadband subscribers is high, catering for good opportunities for students to use DLRs also at home and for parents with good ICT skills. Table 3.2 shows that the population is well educated with an attainment to tertiary education well above the OECD average. This means that parents are generally well educated and could be expected to be more open and positive towards the use of ICT in education.

Table 3.2. **Tertiary education attainment in the Nordic countries**

2005

	Tertiary attainment in age group 25-64 as a percentage of the population of that age group
Denmark	33.5
Finland	34.6
Iceland	30.5
Norway	31.0
Sweden	34.5
OECD average	26.0

Source: OECD (2008), Education at a Glance 2008, OECD Publishing, Paris.

All Nordic countries have large tax-funded public welfare sectors. They all have a large proportion of public funding and public realization of education. Compulsory schooling is free of charge in all five countries and educational materials used in school, including DLRs, are provided to students for free. As shown in Table 3.3, schools are generally well-equipped with computers and Internet connections.

One common feature among the Nordic countries administrative systems is the comparatively small size of ministries, which are mostly involved in planning and strategic issues, complemented with semi-independent government agencies that carry out the plans and programmes. Thus, in the education sector agencies such as the Danish Uni-C, the Finnish National Board of Education, the Norwegian Directorate for Education, and the Swedish National Agency for Education have been instrumental in implementing the ICT policies and programmes issued by respective government. The exception here is Iceland where the Ministry of Education, Science and Culture

Table 3.3. **ICT infrastructure in Nordic schools (2006)**

	Computers per student	Percentage of computers connected to the Internet
Denmark	0.21	92.2
Finland	0.18	92.3
Iceland	0.21	98.2
Norway	0.30	90.4
Sweden	0.17	93.0
OECD average	0.19	88.0

Source: OECD (2006), PISA 2006 Database.

performs both the planning, and strategic functions and implementation functions.

All five countries have a similar structure with a shared responsibility for the schools between national and local authorities. Table 3.4. shows that all five countries have a fairly decentralised decision making structure, where most decisions are taken on local and school level.

In all countries it is the role of the local authorities to run the schools, to employ teachers, and purchase equipment within a legal framework set by the state. State grants are distributed but usually as lump sums which might be supplemented with money from local taxes. Curricula are national and relatively open for interpretation on local level. Constructivism and related pedagogical theories are widely acknowledged. Teachers are given large autonomy and responsibility to choose both pedagogical methods and materials to work with. (Eurydice, 2005) In terms of ICT, the decentralisation means

Table 3.4. **Percentage of decisions taken at each level of government in lower secondary public education**

2007

	Central	State	Provincial/ regional	Sub–regional	Local	School	Total
Denmark	19	–	–	–	40	41	100
Finland	2	–	–	–	76	22	100
Iceland	23	–	–	–	37	40	100
Norway	25	–	–	–	40	35	100
Sweden	18	–	–	–	35	47	100

Source: OECD (2008), Education at a Glance 2008, OECD Publishing, Paris.

that investments in infrastructure as well as purchasing of computers, DLRs and other software to a large extent are local decisions. This also means that there are few aggregated data on the level of overall ICT investments in each country. Having said this, it should be noted that there are exceptions to this rule in all countries – examples of complementary national programmes of investments in infrastructure, hardware and in-service training of teachers.

To sum up, there are many differences between the Nordic countries but compared to most other OECD countries they constitute a homogeneous region with strong economies, a tax funded and well developed welfare sector, highly developed ICT infrastructure, an e-mature population, and a decentralised school system. Some of these factors probably affect the use and production of DLRs. Contextual factors that might drive the use of DLRs are schools well equipped with ICT, the number of remote schools in scarcely populated areas, well educated parents that could be expected to be more open to the use of ICT in education, the fact that schools are run by local authorities which also decides on how to interpret the curriculum and which teaching material to buy. On the other hand there are factors or barriers working against an increased use of DLRs in schools such as the fact that all five countries have rather small language groups resulting in smaller markets for DLRs.

The profile of ICT policies in the Nordic countries

The study in question has focused on three out of the five policy components identified by Kozma (2008), namely infrastructure development, teacher training (more precisely in-service training for teachers), and content development. Examining the Nordic ICT strategies from the late 1990s and onwards, it appears as if most strategies from Denmark, Iceland and Norway have covered all three elements in each strategy.[2]

Scope of ICT strategies

As shown by the many strategies and programmes launched by the Danish Ministry of Education, the ministry has taken a very active role. This is worth noticing, at a time in which in many countries politicians and education ministries seem to have lost the zest for active policies on ICT in education. Iceland seems to have moved along the same route as Denmark although with less funding, relatively speaking, for infrastructure and hardware investments. From the mid-1990s there are combined efforts to revise the curriculum, to fund school projects and to launch in-service training for teachers. The Norwegian strategies from the mid-1990s also cover all three areas, with a growing focus on content development. The Finnish strategies appear more sequential and cover Kozma's three policy elements over time. Starting with a focus on investments in hardware, they moved on to in-service training

for teachers, content development and providing support structures. In comparison with the other Nordic countries, Sweden seems to have had the least active Ministry of Education in the field of ICT. Looking at Kozma's three policy elements, Sweden has mainly focused on investments in infrastructure and in-service training for teachers. To some extent this inaction has been counterbalanced by the Knowledge Foundation,[3] which has launched several programmes for ICT in schools and teacher training. But it is noteworthy that very few investments have been made by Swedish authorities in the area of DLRs and no curriculum changes related to ICT have been initiated in compulsory school since the mid-1990s. Instead two other actors launched DLR programmes. Telia, the Swedish state-owned telecom provider, invested EUR 4.5 million in 150 small DLR projects and the Knowledge Foundation invested EUR 10 million during 1996-99 in over 90 DLRs. Since the market for DLRs at that time was estimated to approximately EUR 2.5 million, evaluators of the programmes were critical to the large size of the programmes and pointed at them as a reason for slow progress in the commercial market (Ministry of Education, 2002).

Investments in infrastructure

The history of educational ICT policies and implementation in the Nordic countries seems to fit well into the overall pattern described by Kozma (2008). It is more difficult to find the kind of sequence that Lee (2003) is describing, going from a focus on investments in infrastructure to DLRs, use of technology and teacher training. Infrastructure investments have been an important part of most national strategies and implementation programmes since the mid-1990s. The amounts spent on equipping schools with hardware and establishing high speed connections to schools, even fairly recently, is not in line with Lee's hypothesis. This means that the Nordic experience does not support or confirm Lee's hypothesis. In the most recent Danish programme ITIF (2004-07), computers to schools form an important part. Approximately 75% of the resources have been earmarked for the acquisition of computers for pupils in 3rd grade. In the latest Swedish initiative (1999-2002), the Swedish government spent about 80% of the resources on upgrading school Internet access and handing out laptops to teachers. In the Finnish strategy in force from 2007 onwards, increased bandwidth and ensuring compatibility within the information infrastructure is listed as one of the central goals. Also a Norwegian initiative to provide broad band to all schools has been in effect during the new millennium. In all Nordic countries the local educational authorities also have a rather large responsibility regarding ICT equipment for schools. Taken together, national initiatives and local responsibility have resulted in well equipped schools with good Internet access, according to international standards.

In-service training of teachers

Initial and in-service teacher training has been another central element in the Nordic countries' ICT strategies. Although all Nordic countries have a decentralized responsibility for in-service training for teachers most countries have had major governmental initiatives in the field of ICT education for teachers. In Sweden about 60% of all teachers received in-service training in the use of ICT during the ITiS programme (1999-2002). Since then, competence development is almost exclusively a local responsibility. According to Norwegian research (Erstad, Silseth and Dalaaker, 2008), about half of the Norwegian teaching force had been involved in governmentally financed or supported supplementary education in pedagogical use of ICT by 2004. In Finland extensive financial support has been given to the local authorities for teachers' participation in ICT related in-service training. In Denmark and Iceland local authorities have put up the lion part of the investments in in-service training for teachers during the last ten years.

In a large survey by Ramboll Management (2006) on the impact of ICT on teaching and learning comprising all the Nordic countries except Iceland, teachers were asked what kind of competence development they had participated in within the last three years. Overall two thirds of the teachers have participated in ICT workshops or courses during this period, but only a little more than one-third of the teachers judged that they had sufficient competence in using ICT in their teaching. The authors also point to an interesting dichotomy: "[i]t is in Sweden that the fewest teachers have participated in

Table 3.5. **Comparison of Nordic teachers' use of ICT**[1]

	Teachers who have used computers to prepare lessons during the last 12 months	Teachers who have used computers in class during the last 12 months	Teachers with very good ICT skills experienced by themselves	Propensity to take up computers and the Internet in classroom situations (based on access, competence and motivation[2])
Denmark	95.7	94.5	60.2	235
Finland	94.5	85.1	35.4	206
Iceland	96.0	79.5	41.3	178
Norway	95.5	89.4	49.8	232
Sweden	91.5	90.9	43.3	203
EU 25+2 average	89.3	74.5	40.0	211

1. Average values for all teachers in primary, lower secondary, upper secondary and vocational education.

2. For the explanation of the terms "access", "competence" and "motivation", see Figure 2.1.

Source: Benchmark Access and Use of ICT in European Schools 2006, Empirica (2006).

competence development within the last three years, but it is also in Sweden that there are the most teachers who, to a great extent, feel that they have sufficient ICT competence. In Norway it is just the opposite. The majority of teachers in Norway find that they do not have sufficient competence even though that most of them have participated in competence development within the last three years." Two alternative explanations are offered. The first is that the latest Swedish initiative, ICT in schools, was carried out more than three years before the study. These teachers might have had more time to practice their ICT competence than Norwegian teachers, where the latest initiative was carried out during the last three years before the study. The second explanation is that teachers who have not participated in competence development within the last three years have become self-sufficient and do not question their (perhaps lacking) skill level, and therefore feel more confident. The study concludes that the four Nordic countries participating in the study in general have had "a strong focus on competence development for teachers regarding the use of ICT for teaching and learning purposes" (Ramboll Management, 2006).

Looking at the output in terms of teachers' use of ICT in their teaching, all countries score above the EU average in teachers' use of computers in preparing lessons and using computers in class. Looking at differences between the Nordic countries (see Table 3.5), Danish teachers seem to be most willing to use ICT and also most ICT confident.

The differences in teachers' propensity to use computers in their teaching are also visible in the actual use as reported in the PISA (2006) study. Table 3.6 displays students reported use of computers in their homes and in school. Although students from all Nordic countries report home use that is higher than the OECD average, only the Danish students also report higher use of computers in school.

Table 3.6. **Percentage of students reporting frequent use of computers at home and in school**

	At home	In school
Denmark	95	65
Finland	93	51
Iceland	97	53
Norway	96	54
Sweden	96	47
OECD average	86	55

Source: OECD (2006), PISA 2006 Database.

Content development

With some exceptions DLRs have not been prominent features in Nordic ICT strategies until recently. But this does not imply that countries have been totally passive in the field up till now. Already from 1986-99 an exchange scheme of educational software among the countries took place under the auspices of the Nordic Council of Ministers (see Box 3.1).

Box 3.1. **The Nordic exchange initiative**

In order to share costs and distribute risks the Nordic countries cooperated during 1986-1999 to initiate and produce DLRs. They gave permissions to each other to translate and adapt nationally produced digital educational materials. The cooperation was almost exclusively limited to CD-ROMs. Part of the success of the Nordic exchange initiative may be attributable to the "small is beautiful" principle and similarities between the pedagogical approaches of the countries involved.

The demise of the Nordic exchange came at a time when the production of small-scale education software was decreasing and it was becoming difficult and costly to undertake localisation of the increasing number of large, complex multimedia CD-ROMs. As the market has evolved, however, the focus is now again much more on the development of small, re-useable learning objects. It may be timely, therefore, to revisit the Nordic exchange model.

Source: Swedish Ministry of Education (2002) and eColours project (2006).

Sweden has not had governmental support for production of DLRs on the agenda during the last 20 or so years. Having said that, there has been governmental support to national agencies for developing and running the national school web (IT for Teachers, SE1) as well as DLR repositories (the largest one has been the Course Hub, SE2). The case is similar in Finland and Iceland. In Finland there has been very little coherent and systematic support for the production of DLRs at the policy level. Digital learning object development however seems to be an exception to this. Both the National Board of Education and a number of Finnish schools have been active in EU-funded projects by producing digital learning objects. In the latest Icelandic strategy, *Risk with responsibility* (2005-08), digital content is introduced as one of five visions. Access to digital learning materials available in Icelandic language is raised as an issue. It should also be noted that the government funded National Centre for Educational Materials has been producing DLRs since the late 1990s. Although DLRs do not appear as a separate objective in the Norwegian strategies until the 2004, resources have been allocated to

the area. From 2003 focus has been given to a dedicated campaign for DLR in upper secondary education and to projects related to specialist subjects, students speaking minority languages and students with special needs. In Denmark there has been governmental support for production of DLRs for the last ten years. Both the strategy *ITMF,* which ran from 2001-04, as well as *ITIF,* running from 2004-07, have included funding for content development.

Alignment with overall ICT strategies

Kozma (2008) concludes that national ICT policies will have the greatest impact if they are aligned with other strategic and operational policies. Again, Sweden can be singled out as the country with the least alignment between overall national ICT strategies and strategies for ICT in schools. The Danish national strategy for the global economy from 2006 states that the integration of ICT in all school subjects is an important means to reach the goal of having the world's best public schools. In 2006, the Norwegian government made the ambitious statement that Norwegian schools should be world leaders in their use of ICT. During 2006, a *National Knowledge Society Strategy for 2007-2015* was drafted as part of the implementation of the Finnish government's Information Society Programme. The recently published Icelandic Government policy (2008) on the information society states that "[i]nformation technology shall be employed to a still greater extent in education and teaching, and the diversity of education on IT shall be increased significantly". The latest Swedish national ICT strategy was issued in 2005. Its goal is to build a more digitised information society for all. ICT in education is seen as one of the means, but no particular strategy or programme for ICT in schools was launched at this point. In 2006 there was a change in government, and the new coalition has, so far, not formulated any policy or launched any programme regarding ICT in education.

Conclusions

A number of contextual factors that might affect the use and production of DLRs in the Nordic countries has been identified. Among them are well equipped schools, well educated parents and local authorities with the right to interpret the curriculum and purchase educational materials. The history of ICT policies in the Nordic countries shows that the governments regard ICT as an important element in the continuous improvement of the school sector. With the exception of Sweden, all countries also show a growing interest in DLRs as a mean to introduce innovation in education and improve educational outcomes. The next three chapters will look into how different actors initiate innovation.

Notes

1. It should be noted that while Scandinavia consists of Denmark, Norway and Sweden, the Nordic region also includes Finland and Iceland.
2. For a more detailed description of the ICT policy programmes for education in the Nordic countries, see Appendix B.
3. The Knowledge Foundation is a public-private foundation. Its remit is to boost Sweden's competitiveness by means of inputs that, in the long term, improve the joint capacity of the business sector and the academic world to develop knowledge and competence. Its aim is for Sweden to remain a globally competitive nation.

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Chapter 4

Government-Initiated Innovations in the Nordic Countries

The following three chapters will compare how the different phases of innovation are manifested in the Nordic countries. Given the theoretical framework developed in Chapter 2, there will be a special focus on drivers and barriers, and on explaining some of the outcomes of the innovation process. This chapter will deal with government initiated innovations, in particular the five national educational portals.

Initiation and implementation of national portals

In the planning process of the DLRs project it was agreed that national educational portals would be one of the cases for closer study for all participating countries. Since all five countries have some kind of national educational portals initiated by the Government it was decided that this would provide a useful common framework for comparisons.

The main driver behind the decisions to initiate school portals on the Internet seem to have been a wish to promote the use of ICT in schools coupled with a low level of knowledge in schools regarding ICT issues. Since the concept of ICT in education, and particularly the use of Internet in schools, was fairly new in the mid-1990s many countries felt a need to support the local development at central level. In the Nordic countries this was generally done both by showcasing what could be done with the use of ICT, and by gathering DLRs for schools to use. Thus Denmark, Finland, Norway and Sweden all instigated national portals – commonly named school computer networks – in the mid-1990s. In Iceland a private company called Ísmennt performed many of the functions of a national educational portal at this time and participated in the Nordic cooperation. In 1994 the Nordic Council of Ministers also took the initiative to establish a Nordic school network, called ODIN, which was active until 2007.

At that time the term "school computer network" was commonly used, at least in Europe. Given that some of these developments took place before the expansion of the Internet as a common platform for communication, the idea of a network might need a short explanation. Already during the 1980s a number of school computer networks were established in Europe and North America. The communication platforms were mainly mainframe computers run by universities or large-scale co-operative exercises, but in some cases PC-based systems were also used. Due to technical limitations, network activities were often restricted to the use of e-mail and access to databases. The situation changed radically in the mid-1990s thanks to the rapid growth of the Internet. The environment for school computer networks became completely different. Most of the first generation of networks adapted to the new situation and began to use the Internet as the vehicle for communication. During this time there were two fairly distinct groups of school computer networks; on the one hand national information networks aimed at all schools, on the other hand smaller computer networks typically involving 50-100 schools and a large number of very small networks. The national networks were often the result of initiatives taken by national education authorities – sometimes in co-operation with telecom operators – while the smaller networks originated from initiatives taken by regional authorities, universities and groups of pioneer enthusiasts. Focus was generally on offering teachers good quality content – a strategy sometimes called "content pull" as a contrast to "technology push" where the technology in itself is more in focus. In short: a "school network" was seen as an open service for schools focused on web-based resources and services (Hylén, 2003).

As described in the first section of Chapter 3, "The Nordic context", the standard procedure in the Nordic countries is that the long term strategies are made in the ministries but carried out by government agencies. In the case of ICT in education, the responsibility for the implementation and day-to-day operation of strategies and programmes has mostly fallen on UNI-C in Denmark, the National Board of Education in Finland, the Directorate for Education and Training in Norway, and the National Agency for Education in Sweden.[1] This relates particularly to the national educational portals. The exception in this case is Iceland where the responsibility for carrying out the ICT strategies has remained in the Ministry of Education.

At the time the national portals were first initiated, *i.e.* the mid-1990s, the concept of learning platforms, or virtual learning environments (VLE), did not exist (Paulsson, 2008). The national portals were not looked upon as repositories of DLRs, but as show-windows for schools, including pedagogical tips, link repositories, etc. The deployment of VLE in schools came in the early 2000s and, although there was some push from commercial players that the future for DLRs consisted of the exchange and interoperability of SCORM[2] Learning Objects within standards' compliant learning platforms,

this does not seem to have affected the strategies for the national portals in the Nordic countries.

The Danish portal EMU (DK1) was not without predecessors but it inherited on birth the earlier services incorporated in and/or developed and maintained by UNI-C. So, in designing and launching the service, UNI-C could capitalise on the experience the users had of the preceding services. Moreover EMU has been piggy-backing the other national DER initiatives of boosting ICT usage in schools to gather the necessary momentum.

In Finland the idea of a national portal, called EDU.fi (FI1), together with a Virtual School was initiated by the National Board of Education who appointed a working group with representatives from educational publishers, the national broadcasting company, municipalities, state provincial officials and the Ministry of Education. EDU.fi was developed to serve as a portal for the various sub-projects and a repository for materials and ideas produced.

The concept for the Icelandic Gateway (IC1) was first discussed in the late 1990s, and formal planning began in earnest in 2000. Until then a private company operated a web site, called Ísmennt, which served some of the functions of a national portal. In 1996 the Ministry of Education, Science and Culture bought part of the company and outsourced the running of the company to the University College of Education. It was sold again in December 1999. The spin-off of the day-to-day operations of the Educational Gateway was done under a competitive tender process. The rationale was to better tap the technical expertise available in the private sector. In addition, as noted in the section below, entitled "The innovation process of other governmental initiatives", this arrangement allowed for more flexibility in the type of content included on the Gateway, as inclusion on a portal run by a private firm would not be seen as having official stipulation from the Ministry itself. Nevertheless the link to the formal school sector in Iceland remained strong.

The portal Utdanning.no (NO1) was launched in spring 2003 by the Norwegian Ministry of Education and Research. It has a much broader scope than the original Skolenettet in that it covers the whole educational sector, from primary school, to secondary school, vocational, adult and higher education.[3] One central aim of Utdanning.no is to support the educational system in its efforts to innovate and develop using ICT. The portal contains relevant content as well as educational career guidance. It is perceived by the government as an important instrument to secure the quality of the digital content used for educational purposes, and also as an instrument for making this content available for potential users. The mechanism is similar to a Nordic tradition in the use of common land and common usage of natural resources in forests and on mountains, such as hunting, fishing and berry picking. The idea, called "digital commons", is to share and re-use digital resources

through the Internet for non-commercial purposes. The main point is to make information, such as publicly funded research findings, available free of charge to the general public.

The Swedish national portal, called IT for Teachers (SE1), is described as acting as a broker for a variety of ICT resources and its target users are school teachers and leaders. It provides links to digital learning resources, courses in using ICT, computer programs, suggestions for using ICT in school and reports of teacher experiences. It is a portal run by the National Agency for Education which provides a shortcut to other web resources. The resources associated with different areas of the web site were developed separately through different projects over the previous 10 years. In 2007, these resources were brought together and made accessible through a single portal. When bringing the resources together in this way, the opportunity was taken to focus the resources and services on supporting teachers, rather than learners and other members of the community. The site declares clearly that teachers are the main focus.

As regards the role of stakeholders in the initiation of innovations, it seems as if very few of the DLR cases in this study consulted with stakeholders to any significant degree before being launched. One exception is the Virtual School (FI1) which was initiated by a working group with representatives from educational publishers, the national broadcasting company YLE, municipalities, state provincial offices and National Board of Education and the Ministry of Education.

When initiated, the national portals were supply-driven rather than demand-driven, or driven by a delivery rather than an engagement strategy. This does not imply that the innovations have been forced on students or teachers. Teachers and students are free to use or not to use the content or services. It should be noted though that there is no evidence of a clear demand from teachers or students to have a national educational platform in the mid or late 1990s. Nordic government agencies did a great deal of information and awareness-raising activities to increase knowledge in schools about how to use ICT and particularly the Internet in education. The fact that the EU Commission, together with member countries, ran an annual awareness raising activity, called Netd@ys, from 1997 until 2004 shows there was a need to create a demand. Paradoxically enough, it might be that the lack of involvement of stakeholders in the mid-1990s worked in favour of the initiation of the innovation. The same argument could be raised today – sometimes teachers and other stakeholders might need to be convinced, the innovator might need to create and cultivate a demand not yet existing. The ICT sector could probably provide a number of examples where new devices, software and services have been introduced to a non-existent market.

Moreover it should be noted that the knowledge base regarding web-based DLRs and how to build educational portals was weak at the time. This is probably the reason why there seems to have been much policy borrowing among the Nordic countries as well as peer-learning among senior officials responsible for the national portals and staff involved in the daily operations. Although the Nordic software exchange initiative (see Box 3.1) mainly considered exchange of DLRs, it seems also to have functioned as a platform for exchange of experiences and ideas. The exchange of experiences going on within the framework of the European Schoolnet (EUN) is another example. EUN has a good record of coordinating EU funded research and development projects in the area of DLRs where countries are invited to participate together with researchers and commercial companies. In a survey targeting, among others, members of EUN's different steering committees, it was stated that the three greatest strengths were the fact that EUN had managed to establish itself as a human network between decision makers, national school networks and ICT experts. The possibilities to exchange experiences with peers, and establish close contact with research and innovation were also frequently mentioned (Hylén, 2003).

Implementation and scale-up of national educational portals

Today's Nordic national educational portals had their origins in school computer networks in the 1990s. Although the political interest in national educational portals has recently faded in some countries, it did not result in their discontinuation. After going through several stages of development, as described in Table 3.6, they have ended up as portals bringing together results from a number of governmental initiatives. At the moment they are best described as hubs of resources, stemming from a number of government initiatives. It seems clear that countries have not used pilots before launching the portals but have developed them using a model of incremental development.

As already mentioned, all of the portals mostly use a delivery strategy, not an engagement strategy. They deliver different types of content, rather than engaging their users to be co-producers. The use of Web 2.0 technology is still limited. Most portals provide information on how teachers can use tools such as blogs, wikis, and podcasts in school. But so far there are, for example, limited opportunities for teachers to submit their own DLRs or for students and teachers to discuss and comment on items published by the educational authorities. This might be an example of the role of a government agency with a political responsibility clashing with current trends on Internet use and perhaps also with expectations from users.

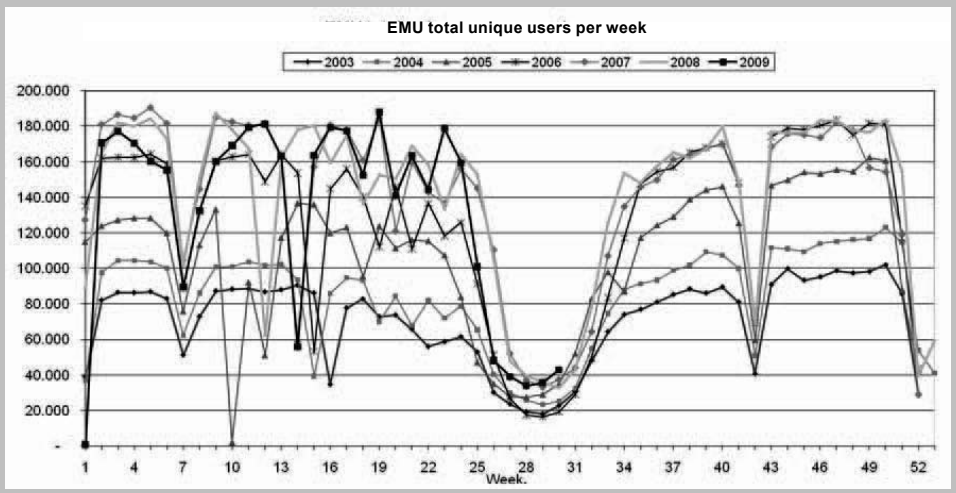
Monitoring and evaluation of national portals

The day-to-day monitoring of the national portals is mainly done through user statistics and feedback, which can be more or less systematically gathered. User statistics can be a valuable source of information, depending on how detailed the information is (see Box 4.1). But statistics sometimes need to be complemented by fully fledged evaluations.

Some countries have established formal routines or ways for collecting views, ideas, and criticism. For example in 2005 the Norwegian Ministry of Education established SANU as a co-ordination committee for websites in the educational sector. SANU has two areas of interest: content coordination and technical solutions between websites. It strives for better user

Box 4.1. **Example of web user statistics – the case of EMU (DK1)**

Web statistics can show the number of users that have logged in to a web portal at any given hour, day or week. Depending on the tools used, information can also be given on how long (in minutes) users usually stay on each of the pages in the portal, the route they take from the front page and through the site, from where they came – if they went directly to the portal from a known link or if they found it through a search engine (Google, Yahoo, etc.) where they come from (which country). The example below shows the number of users per week for the Danish national portal EMU for the last five years. Each year there is a decline during the summer break in the middle of the year and the winter break at the end.



Source: Country Case Report Denmark (2008).

friendliness, utilization of resources and sharing of assignments. The goal is to avoid overlap of content, to seek the best solution to problems and to provide comprehensive information to users. In Denmark UNI-C have established user groups related to EMU from primary and secondary schools as well as school librarians. Both Utdanning.no (NO1) and EMU (DK1) have established external editorial groups, mainly consisting of teachers. Also IT for Teachers (SE1) has a teacher reference group which meets twice a year to reflect on practice and offer ideas for development.

There was relatively little evidence on formal assessments of the national portals. IT for Teachers (SE1) conducted two user evaluations during 2006/2007 and 2007/2008 (Dittmer, 2008). They were complemented by non-systematic site visits to schools by the editorial team. The surveys were conducted before and after the launch of the renewed site and showed improvements both in numbers of users and user satisfaction.

The EDU.fi (FI1) and the Finnish Virtual School projects were evaluated by the staff from the hosting organisation the National Board of Education in 2005. The evaluators were positive about the development of the Virtual School so far and recommended the establishment of a national Virtual School, building on the local projects developed so far.

Apart from these two examples, there seems to be a very limited use of systematically gathered evaluation data. The OECD review teams report that the monitoring of the portals is "based primarily on qualitative data gathered informally by each of the stakeholders respectively. Statistics and user feedback has not been systematically designed and implemented. Fairly general user statistics are gathered". (Country Case Report Denmark) Another report states that "[t]o date, the development has not been data-driven, and there has been little formal formative or summative assessment. Perhaps as a result of this informal initial development process, much of the monitoring and evaluation of the activities and impact ... have been informal and not systematized. Rudimentary site traffic statistics are available, but have not heavily influenced the development of the portal." (Country Case Report Iceland) Similar statements could be drawn from the other country case reports regarding both the national portals and other government initiated projects.

Monitoring and evaluation are ways of making tacit knowledge explicit. An evaluation should cover a more complex set of issues related to an innovation, much more could be learned from evaluations than plain web statistics and unsystematically gathered views from users, and thus expand the knowledge base. Finally, one should ask what role stakeholders have in the monitoring and/or evaluation of innovations. Building on the facts known about the cases, some of the stakeholders were involved in the evaluation process – students, teachers, researchers, private companies and government agencies only to mention the most common. But it should be noted that they

are involved either in their role as users (students, teachers), as performers of evaluations (researchers) or as initiators and/or funders (government agencies, private companies) and not really as stakeholders.

Evaluations of ICT in education

Judging from the limited use of formal evaluations by the national portals, it could be asked if lack of interest in evaluation is a general trend within the broader field of ICT in education. But in contrast to the limited number of evaluations of national portals, most countries seem to have done more systematic evaluations of the outcomes of their overall ICT policies (see Table 4.1). Denmark reports several evaluations conducted by external researchers or consultant companies during the last eight years. (Dalsgaard, 2008) Finland also report on several national studies on IT skills and ICT use up to 2000, and participation in a number of international studies. (Taalas and Kankaanranta, 2008) Norway has also participated in several international studies and run annually an extensive survey, called ITU Monitor, conducted by independent researchers. (Erstad *et al.,* 2008) Iceland's major "nuclear school" project was evaluated in 2002. An evaluation of the development fund from 1998-2002, which also included ICT in education, was carried out in 2004. (Macdonald, 2008) In Sweden three external evaluations were done of the latest ICT programme, ITiS, in the early 2000s. Two were done by different research teams and a third by the Parliamentary Auditors who studied the economic aspects of the programme. In the 1990s, international researchers also studied the outcomes of the programmes launched by the Knowledge Foundation. Sweden, together with Iceland, has also had the lowest participation in international studies on ICT in education in the last five years.

Table 4.1. **Country participation in international studies on ICT in education**

	E-Learning Nordic 2006	SITES Module 1	SITES Module 2	SITES Module 3
Denmark	x	x	x	x
Finland	x	x	x	x
Iceland		x		
Norway	x	x	x	x
Sweden	x			

The innovation process of other governmental initiatives

Other than the national portals, a number of government instigated projects and services have been put forward as cases of particular interest to this study. These include the ITIF programme (DK3), the National Centre for Educational Materials (NCEM) (IC2), the awareness raising project You Decide (NO3), and the Course Hub (SE2).

The pattern that appears from these examples of government initiated projects is similar to what could be seen from the national portals. Only rarely is research or systematically gathered experiences used in the design. Strategic planning seems also to be infrequently used, the Norwegian campaign You Decide (NO3) being one of the exceptions. This innovation is also an exception regarding involvement of stakeholders in the initiation phase. You Decide seems to have been the only case that involved any stakeholders before launch. Students were consulted before the launch and participated in the design phase.

The issue of scaling up in terms of enlarging the target group seems not to be on the agenda in any of the programmes or projects initiated by the Nordic governments. This might have three reasons. The first and most obvious is that, since they are government initiated, they are done on a more or less national scale already to start with. This is not only true in the case of the national portals but also in the case of the You Decide (NO3), the Course Hub (SE2) and the materials produced by NCEM (IC2). The second reason has to do with the technology – there are costs involved in developing digital artefacts such as DLRs, but, as already noted, once developed there are no or low costs in multiplying them or making them available to more users. A third reason might be that the ICT area is a very rapidly developing field and there might be limited time for pilots. Countries seem to have used iterative development processes or a step-by-step or incremental approach rather than using pilot projects before launching their national portal or educational gateway.

Conclusions

This section tries to draw together the evidence from analytical and empirical findings discussed above in order to provide some overall conclusions regarding the process of developing government-initiated DLR innovations, in particular national portals. In so doing, it focuses specifically on the drivers and barriers affecting the process as well as the way the knowledge base was used.

Four of the five Nordic countries instigated national educational portals in the mid-1990s. In Iceland at first a private company performed the functions of a national portal, before it was bought by the Ministry of Education

and turned into a national portal. All the portals have grown incrementally, undergoing several stages of development. When the portals were launched, they all targeted both students and teachers. Although they have chosen somewhat different strategies they all offer similar services (such as thematic DLRs and activities for teachers to use, in-service training, links to relevant websites, etc.). Web statistics and non-systematic gathering of user feedback seem to be the most common knowledge base, although at least one (SE1) has used a formal evaluation and another (FI1) academic knowledge on different stages of their development. In addition, informal sharing of knowledge and experience among countries seems to have been another way of informing their development. Looking at other government initiated innovations, the pattern is similar. Only rarely are stakeholders involved and only rarely is academic research used before launch or evaluations during the implementation and scale-up. This contrasts with a much more systematic use of evaluation and research of national programmes and policies of ICT in education.

At the time the national portals were initiated, there were several barriers that posed challenges to their development and implementation:

- The knowledge base for this kind of innovations was weak. There was not much academic, or other codified professional knowledge to build on. This is probably one reason why peer learning among experts from ministries and national agencies, for example under the auspices of the Nordic Council of Ministers and the European Schoolnet, has been so important.
- The involvement of stakeholders seems also to have been weak. None of the Nordic countries seem to have had regular meetings with groups of teachers, principals, representatives of local authorities, educational publishers or researchers before launching their educational portals. Again, the lack of existing models and lessons to learn from at the time should be kept in mind.
- There is no evidence of a demand from teachers or students in the mid or late 1990s to have a national educational platform.

However, there seems to have been one strong driver – a sense of urgency among educational decision makers that ICT would change our societies dramatically. Consequently the schools needed to change as well. This was coupled with the belief that ICT could advance educational reform. As visible from the Nordic countries' national ICT strategies from that time (see Appendix B), these arguments, together with the ambition to support economic growth by developing human capital and promoting social development and enhancing social cohesion, were the rationales for justifying investments on ICT in education.

Closely related to this is whether digital competence is considered a key competence for the future or not. Some countries have taken into account the European Commission and European Parliament declaration of digital competence as a key competence for the future (European Commission, 2006) and this in itself often functions as a driver. Among the Nordic countries this is most explicitly used by Norway which has adopted digital competence as a basic skill in the curriculum, integrated in all subjects. Denmark, Finland and Iceland have, to various degrees, implemented policies to the same effect. In Sweden it is still being discussed how and to what extent this should be done.

A few years after the launch of the national portals, and with the burst of the ICT bubble around the turn of the millennium, political interest was less evident in some countries. In the absence of political leadership, one driving force behind the continuous development and implementation work seem to be senior officials, "entrepreneurs",[4] within ministries or government agencies.

In other countries, like Denmark and Norway, the political interest for ICT in education has remained strong, resulting in new government initiatives like ITMF, The Virtual Gymnasium and ITIF in Denmark (Dalsgaard, 2008) and the programme for digital literacy with the inclusion of digital competence as a core competence in all subjects in Norway (Erstad *et al.,* 2008).

Building on the evidence provided from the national background reports (Dalsgaard, 2008, Macdonald, 2008, Erstad *et al.,* 2008, Hult and Westerdahl, 2008), only one example, the Virtual School (FI1), can be given where any of the national portals directly used research or researchers during the development and implementation phases. Instead there was more reliance on policy makers' professional knowledge and, in some cases, the professional knowledge of ICT companies. As a result, peer learning among senior officials responsible for the national platforms and policy borrowing were important sources of knowledge.

Notes

1. During 2003 08 issues regarding ICT in education were the responsibility of the National Agency for School Improvement. Since July 2008 this agency is no longer in operation.

2. According to Wikipedia SCORM is the acronym for Sharable Content Object Reference Model, which is a collection of standards and specifications for web-based e-learning. It defines communications between client side content and a host system called the run-time environment, commonly a function of a learning management system (*see http://en.wikipedia.org/wiki/SCORM).*

3. Skolenettet still exists as the Directorate of Education's website for teachers, learners and parents. It contains, among other things, the curriculum and linked DLRs related to the latest reform in compulsory school, called Knowledge Promotion.

4. Wiktionary defines "entrepreneurship" as the practice of applying entrepreneurial skills and approaches within an established company (see *http://en.wiktionary.org/wiki/intrapreneurship).*

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Chapter 5

Innovation Initiated by Commercial Actors

This chapter will look into the different phases of innovations initiated by publishing companies and educational broadcasters. Again a special focus will be placed on drivers and barriers, *i.e.* whether particular drivers and barriers can be found in different countries, explaining some of the outcomes of the innovation process.

Innovations by educational publishers

The educational publishers in the Nordic countries have encountered an ambiguous situation regarding DLRs. Through different strategies and programmes, the Ministries of Education have supported the use of ICT in schools. Sometimes this has been done with financial support to private sector educational content developers, such as in the case of the ITIF programme (DK3). Sometimes the government or government agencies have developed content in-house, as NCEM (IC2) does. Finally, sometimes the issue has been ignored by the government, as has been the case in the latest Swedish strategies. Another difficult factor for the publishers is the relatively small language groups and thus markets in each of the respective countries. This is, of course most apparent in Iceland with a population of 310 000 and least in Sweden with some 9 million inhabitants, but is still an issue in all countries since most countries in the Nordic region have immigrant populations with different mother tongues. Finland, Norway and Sweden also have minority language groups – a Swedish speaking minority in Finland and different versions of Sami dialects in all three countries. Even so, there is a vivid commercial market for printed text books in all countries but Iceland, where the NCEM covers most of the market. But, regarding DLRs, the situation is more complex.

In Denmark the government agency UNI-C was active producing DLRs until 2007 and thus was a competitor to the private sector. The portfolio of products developed within UNI-C has since then been taken over by a private company. In Iceland NCEM (IC2) is state-run and financed by annual budget

allocations. In 2008 they offered 380 online titles. In Norway the government intention of stimulating both the public and the commercial market in order to get a rich variety of DLRs, has also been an issue of conflicts according to Erstad *et al.,* (2008). Many of the well-established publishing companies have traditionally been the main suppliers of learning resources for the public schools. With the introduction of DLRs, this market has been challenged. Many producers of the learning resources have expressed concerns of what the future will bring. The two countries with least government involvement in the production of DLRs seem to be Finland and Sweden. Paradoxically though, it seems as if private sector initiatives in DLRs are least common in these two countries and the overall supply of DLRs seem to be poorer.

Initiation of innovation

In Denmark, as in many other countries, the traditional practice has been for private publishers to sell textbooks to schools on an individual basis. Publishers found it difficult, if not impossible, to produce and sell DLRs on this basis. Profitable products were rare exceptions, and hence it was not possible to fully use the functionalities of digital resources, especially regular updating of contents and the use of online resources. This problem is now solved since a private company, called Mikro Værkstedet, in 1999 introduced the concept of school subscriptions (DK2). Today more than 80% of Danish compulsory schools subscribe to this service. The main idea behind school subscriptions is that schools pay for learning resources and services on a yearly basis. Schools subscribe to a package, which is regularly updated and expanded by new additions. For developers of DLRs this means that they get a better overview of their financial situation, because they have a more steady income. This has made it easier to plan for future products and developments. For schools, subscriptions mean that they constantly receive new learning resources, and that the resources are always up-to-date. The company has now expanded its operation to Norway and Sweden as well as other countries. In short, the introduction of school subscriptions has had a significant influence on the spread of DLRs in Danish schools. Within a few months after the launch in 1999, other companies followed suit and the subscription model has become a widespread practice among Danish publishers.

In Norway the private actors in the DLR field have recently developed an initiative called DigLib – a portal where DLRs from a number of commercial actors can be found. Behind the initiative one can find the large Norwegian publishing houses, some media companies together with a vendor for learning management systems. The purpose of the platform is to make available a sustainable solution for easy access and to simplify the distribution of DLRs to schools. Currently, the most comprehensive DLR production in Norway was started by Aschehoug (NO2) in 2001 with seed money from the Government. They developed a platform that is continuously expanded with new titles.

As noted, Finland and Sweden seem to have a less well-developed commercial market for DLRs, although the two largest media companies in the Nordic region – the Swedish Bonniers and the Finnish Sanoma – come from these countries. According to market statistics from the Swedish Association for Educational Publishers representing 70% of the educational market, DLRs constituted about 2% of the sales in 2007 (EUR 1.7 million) and there are no signs of a large increase in the coming years. (FSL, 2008) Similar data has not been possible to find from Finland or Iceland. This might be compared though with an estimate of the Danish market for DLRs on a total of some EUR 15 million, by Mikro Værkstedet (Country Case Report Denmark). In a review of the Norwegian national strategy, *Programme for Digital Literacy 2004-2008*, Ramboll (2008) concludes that there is a need for innovative thinking and new business models to get the Norwegian DLR market off the ground. But the Norwegian market for DLRs seems to be more developed than in some of the other Nordic countries. In 2008 the chairman of the Norwegian Association for Educational Publishers stated that he expects DLRs to have a 15-20% share of the Norwegian education publishing market in four to five years (Metamatrix, 2007).

Knowledge base used

Educational publishers have a long tradition of using researchers and well reputed teachers to review materials before publishing. User feedback on products is also commonly used. But there is little evidence from this study that publishers regularly use ICT related research evidence or researchers before launch or during implementation of new DLRs. One example though is the Norwegian publishing house Aschehoug which developed a new digital publication platform with a number of titles (NO2), based on research evaluations initiated by the Norwegian Directorate for Education and Training in 2001.

Monitoring and evaluation

A clear and unambiguous way of monitoring and evaluating private sector DLRs is of course to look at sales statistics and revenues to the company from individual products and services. But such figures are seldom public and furthermore there are other aspects of importance to the education sector to be looked at. Other indicators of market developments could be mergers and acquisitions.

The subscription model (DK2) has raised some issues in Denmark regarding the freedom of choice for teachers. Traditionally, the Danish education system highly values the responsibility of schools and individual teachers for their professional work. Deciding on what learning materials to use is crucial in this respect. The subscription model, however, implies that individual teachers have less choice than they might want, as it is mostly schools and municipalities

that decide on the contracts. So: there is freedom of choice for schools and municipalities as they can choose between different publishers. But once the choice has been made, the freedom is limited for the teachers concerned. Because of economic constraints they might have a restricted choice of DLRs. There is a dilemma here. More flexibility makes the scheme less profitable for publishers. At the moment publishers are looking into options for making subscription more flexible, leaving more choice for individual teachers or subject-sections in schools. According to interviews by the OECD team visiting Denmark, schools and teachers would prefer to have a contract for the materials they value positively and want to use, rather than for a whole set components of which might not be good enough or appropriate for their situation. Publishers are aware of this position of teachers and are working on more flexible provision of DLRs, enabling teachers to make choices within the context of the school's contract. It was also noted that publishers have a slightly different view on the amount and type of freedom teachers want. Some publishers argued that they offer freedom to the teachers, by providing them with materials that cover the national curriculum and which are easy to use without much preparation.

Aschehoug (NO2) has on several occasions from 2003 onwards entered into collaboration agreements with upper secondary schools throughout Norway. Schools have been offered courses and conferences in exchange of user feedback on the DLRs. According to Aschehoug (2008) this feedback has been important in shaping the overall design of the content and different offers to schools.

Educational broadcasters

The broadcasting companies play an important role in education in all Nordic countries, with the exception of Iceland. With their status as publicly owned public service broadcasting companies competing with commercial radio and TV channels, they act in a grey area between public and private. According to an internal memorandum from the Swedish Educational Broadcasting Company (UR), which compares recent school related initiatives in the Nordic companies with the British BBC, the Japanese NHK, and the Dutch Teleac/NOT, there are three visible trends within public service web-based offers to schools. (Åkerman, 2007) The first trend is the establishment of clip archives; the second is creation of materials to help students to do their homework; and the third is web-based support for creating own materials. As to the Nordic companies, Åkerman (2007) concludes that the Danish Broadcasting Corporation (DR) and the Norwegian Broadcasting Corporation (NRK) have opted for Internet initiatives targeting schools at the expense of TV productions to the same target group. A similar trend, although not as strong, is visible in the Finnish National Broadcasting Service (YLE). So far, the Swedish UR is the most traditional company in this respect. All four

companies have launched some kind of clip archive. YLE is, so far, alone in offering support to homework and to teachers and students creating their own materials. The rudiments of a similar service have recently been launched by UR. There are embryos of communities of teachers and learners sharing user-generated content on the YLE and DR web sites. Although the Nordic broadcasting companies seem to lack the resources to keep up with the developments in companies like BBC, NHK and Teleac/NOT, they are initiating new innovative services and not only cloning ideas from other countries.

In terms of the development of broadcasting services, there seem to have been very few external consultations carried out prior to their launches. Norway is the exception, with its model copied from Denmark. Similarly, there are no systematic evaluations of the activities available, although statistics are collected on issues such as numbers of downloads or programmes loaned. The services seem also to be internally and informally evaluated on aspects such as accessibility and content. Increasingly, the initiatives try to involve the users, not only to gather their views on already produced materials, but also to come up with ideas on new programmes and to participate in the production process. In this aspect they follow the general Internet trend where user involvement in the production process is prominent.

One of the key issues for these initiatives is to find ways to handle copyright issues. In Denmark and Norway it is done by way of subscriptions for schools; in Sweden by establishing a closed-circuit network. In Finland all materials on the Areena website (FI3) are open to the public. But, judging from the discussions with representatives from the broadcasting companies, there seems to be a low preparedness for demands from teachers who wish to adapt and repurpose content and maybe share it with other schools in Europe or internationally. The growing use of Creative Commons' licenses for open educational resources and new approaches to professional indexing and social tagging of content in repositories are not yet prioritised subjects. In short, there seems to be a shortage of mechanisms that enables the educational broadcasters to engage with and obtain feedback from some of the other stakeholders within the education sector that are defining policy, developing tools and implementing school-based ICT innovation.

Drivers and barriers to private sector innovations

The role of government seed money is a potentially important driver for publishing companies to initiate innovations. Within the framework of this study there are several examples of DLRs produced with initial funding of some sort from government, *e.g.* Aschehoug (NO2), School Web (IC3), and ITIF (DK3). It could well be argued that there is little point in publishers innovating (and taking a risk) with new DLR business models if all they are doing is cannibalizing

a profitable textbook market. This is particularly the case in small countries. Having said this, it should be recognised that there are companies in the Nordic countries making a living out of producing and selling DLRs to schools. Mikro Værkstedet is one, DELC is another, both from Denmark. Although the evidence base is meagre, it seems to be the case that the two Nordic countries where government seed money, *i.e.* public tenders, is most common – Denmark and Norway – also have the richest supply of DLRs. Finland, Iceland and Sweden have not had any government subsidies to content developers during the last ten or so years. There has been seed money to develop ICT tools in Finland and seed money to school projects and development of DLRs in Iceland. Some projects later have turned into commercial companies (see Chapter 6, "Scale-up of user-generated innovations") but no government money to private companies to develop DLRs. Sweden had two initiatives with seed money to DLR developers in the mid-1990s, but nothing since.

Another driver facilitating schools' purchase and use of DLRs seems to be different ways of authenticating users. The Danish Uni-login relieves companies of the burden of ensuring that individual teachers and students are entitled to use the DLRs. A similar system is under development in Norway using a common electronic ID. Aschehoug (NO2) has testified about a significant threshold, regarding registrations and login for teachers, students and companies, needs to be overcome before the use of the subscribed DLRs ran smoothly. In the Nordic countries there are two models of helping schools to find relevant DLRs – one public and one financed by companies. Uni-C in Denmark runs the National Repository of Learning Resources (Materialeplatformen), a database with metadata of both DLRs and printed textbooks. However, it is believed that the portal is primarily of advantage to smaller companies, whose products are made visible on the portal. The larger companies – well known by schools – tend to focus more on their own websites as the place to promote and sell their DLRs. They prefer to make their own presentation of their products. They do not believe that the national portal is the place where teachers find new DLRs for the schools. This approach can be compared to the Norwegian DigLib, owned and run by the big publishing houses together with a major learning platform vendor.

Other means of facilitating the deployment of DLRs in education, and thus increasing the demand for DLR, could be to assist teachers in their choice of new DLRs. User feedback and additional information of the kind Amazon.com provides its customers with could be a driver for further DLRs use. As most teachers are digital immigrants, *i.e.* non-digital natives, they are more used to evaluating books – this can easily be done in a few minutes. But, so far, few teachers have the skills and training to conduct systematic evaluations of DLRs. Guidelines and in-service training could also be drivers for further purchase and use of DLRs.

Looking at barriers, the most important one is that many publishers believe the market is still incipient. In terms of product life cycle, it seems that DLRs are in the "market introduction stage" where: the costs are high, sales volumes are slow, and there is little or no competition. Competitive manufacturers watch for acceptance/segment growth losses: demand has to be created; and customers have to be prompted to try the product.[1] Publishers are making good profits from traditional textbooks which is a disincentive for them to initiate DLR innovations, at least to the extent that they regard DLRs as cannibalizing textbooks. Whether the cannibalizing phenomenon is real is difficult to know. At least some traditional publishers in the Nordic countries have released DLRs. Also of interest is the fact that the Icelandic company School Web (IC3), which so far only have produced DLRs, is now entering into the market of printed books.

The situation for publishers can be described using a well-known matrix developed by the Boston Consulting Group (BCG) in 1970 (Table 5.1). The chart is developed to help companies analyse their product lines.[2]

Table 5.1. **The BCG growth-share matrix**

		Relative market share: High	Relative market share: Low
Market growth share	High	Stars	Question marks
	Low	Cash cows	Dogs

Cash cows are units with high market share in a slow-growing industry. These units typically generate cash in excess of the amount of cash needed to maintain the business. They are regarded as staid and boring, in a "mature" market, and every corporation would be thrilled to own as many as possible. They are to be "milked" continuously with as little investment as possible, since such investment would be wasted in an industry with low growth.

Dogs are units with low market share in a mature, slow-growing industry. These units typically generate barely enough cash to maintain the business' market share. Though owning a break-even unit provides the social benefit of providing jobs and possible synergies that assist other business units, from an accounting point of view, such a unit is worthless, not generating cash for the company. They depress a profitable company's return on assets ratio, used by many investors to judge how well a company is being managed. Dogs, it is thought, should be sold off.

Question marks are growing rapidly and thus consume large amounts of cash, but because they have low market shares they do not generate much cash. The result is large net cash consumption. A question mark has the

potential to gain market share and become a star, and eventually a cash cow when the market growth slows. If the question mark does not succeed in becoming the market leader, then after perhaps years of cash consumption it will degenerate into a dog when the market growth declines. Question marks must be analyzed carefully in order to determine whether they are worth the investment required to grow market share.

Stars are units with a high market share in a fast-growing industry. The hope is that stars become the next cash cows. Sustaining the business unit's market leadership may require extra cash, but this is worthwhile if that is what it takes for the unit to remain a leader. When growth slows, stars become cash cows if they have been able to maintain their category leadership, or they move from brief stardom to dogdom.

As a particular industry matures and its growth slows, all business units become either cash cows or dogs. The natural cycle for most business units is that they start as question marks, then turn into stars. Eventually the market stops growing, thus the business unit becomes a cash cow. At the end of the cycle the cash cow turns into a dog. It seems clear that at the moment many traditional textbooks are "cash cows". The question is if the publishers have any DLRs that are "stars" or "question marks" that might fill the gap if or when the current "cash cows" turns into dogs.

The process of transferring teaching materials from one country to another involves much more than only a translation of the text into the language of instruction. The process, commonly called "localisation" also involves the adaptation of the materials to the national curriculum and pedagogical context. One reason could be that the widely held assumption that a constructivist pedagogical tradition is dominant among Nordic teachers is actually true, and to some extent obstructs the possibilities for international textbook publishers to enter the Nordic DLR market. Other possible explanations include that textbooks are culturally sensitive and does not travel well across borders; that curricula changes country by country and hence that learning resources authored by national teacher teams are selling best.

Conclusions

To conclude this section, it should be noted that most publishers lack confidence that there is a viable market for DLRs. They experience the market as incipient and there is an economic risk involved that should not be underestimated. But, at the same time, it should also be pointed out that there are examples in the Nordic countries of companies making a living out of producing and selling DLRs. It could be said that publishers, who for many years have profited from selling textbooks to schools, have a social responsibility to help develop a country's digital competence. Governments may look at publishers and textbooks in different ways

but, to stimulate innovation in the education sector, they should create frameworks to encourage publishers to respond to the concept of digital competence.

Publishers often rightly state that teachers appreciate materials that help them to implement the curriculum. But this does not mean that teachers want textbooks or textbook-related materials only. They also want easy access to pre-sorted information, to modules they can process and apply in ways that fit their own needs and ambitions, to flexible testing tools, practical tips, examples of good practice, and to communities with other teachers. Publishers could provide a new and different range of services and thereby remain as crucial in the education market as they have traditionally been.

The most important driver is, of course, an effective demand from schools (*i.e.* that schools are actually prepared to buy DLRs at market price). In the absence of an effective demand – caused either by a lack of resources in schools or by lack of interest – it is debatable to what extent publishers can be expected to create a demand and thus a new market. Would it be in their long-term interest to do so? The BCG growth-share matrix, introduced in the section entitled, "Drivers and barriers to private sector innovations", indicates that publishers might have a medium or long-term interest in introducing DLRs, given that the demand is slowly increasing and existing textbooks gradually are getting out of date.

A central driver for innovations on an incipient market seems to be government seed money and public tenders to publishers. Seed money lowers the threshold for publishers to innovate by reducing the commercial risk they are taking. Furthermore, a key driver is to provide schools and teachers with information about available DLRs. The Danish repository Materialeplatformen and the Norwegian DigLib are examples of this. As discussed in Chapter 6, "Knowledge base, monitoring and evaluation", such repositories could be complemented with ways to facilitate the evaluation of DLRs for teachers by providing user-feedback and number of downloads.

If DLRs are cannibalizing an already profitable textbook market then this can also act as an important barrier for publishers with commercially successful printed textbooks. The difficulty of localising DLRs, discussed in the previous section, is another possible barrier, although it could also act as a driver for local publishers.

Notes

1. *http://en.wikipedia.org/wiki/Product_life_cycle_management*.
2. The following explanation of the BCG growth-share matrix is taken from *http://en.wikipedia.org/wiki/Growth-share_matrix*.

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Chapter 6

Bottom-Up Innovations

This chapter sets out to discuss how user-generated innovations in the five Nordic countries have managed to initiate, implement and scale-up their innovations. It looks at the extent to which the innovations are monitored and evaluated and what kind of knowledge base has been used during the innovation process. A number of drivers and barriers to innovation are identified and discussed together with a set of strategies for governments to promote user-generated innovations.

Initiation of user-generated innovations

The most clear-cut example of a bottom-up innovation which has had a systemic impact is the Swedish website Lektion.se (in English *Lesson.se*) (SE4). Initiated in 2001, and still run by the three innovators, the original idea was in itself not radically new – to create a meeting place and exchange platform for teachers and their home grown materials. On top of exchanging lesson plans and similar materials, they built a community. The site has been a huge success. Membership is free and in early 2009 they have over 175 000 registered members – this in a country with about 127 000 teachers (including pre-school, compulsory school and upper-secondary school teachers). Members include parents as well as teachers from neighbouring countries. All materials are free of charge and should be licensed with a Creative Commons license. It is often said that school teachers are reluctant to share their teaching materials but, in the case of Lektion.se, this is not the case. Two possible factors explaining the success is that Lektion.se offers, on a large scale, what teachers have always done on a small scale, *i.e.* sharing tips. The innovative element in Lektion.se is to use the Internet to enlarge the collegial community from single schools to the whole country. The content shared is often not so inventive. The moderators do not pre-select or check the quality of materials. All contributions are welcomed, which might be a second factor explaining some of the success of the community.

As other examples of user-generated innovations, several initiatives will be listed which all have received public funding of some kind. One example from Finland is the Peda.net (FI2) collection of web tools. It is a subscription-based service that emerged out of a small R&D project at the Institute for Educational Research, University of Jyväskylä. This initiative currently provides both municipalities and individual schools with access to: a learning platform or virtual learning environment (VLE) portal that allows teachers to collect and distribute materials; a Web Magazine authoring tool; and OpsPro, a tool for writing, maintaining and publishing the school curriculum. Peda.net membership fees depend on the size and the number of schools in a municipality or the number of pupils in an individual school. Funding for the original project was obtained from the European Social Fund in 1997 at a time when few people within the university were enthusiastic about this sort of project. As is the case in many countries, the driver behind the development of an innovative suite of tools has been the vision, enthusiasm and, sometimes, the dogged persistence of the development team itself.

In spite of the small educational market and a large government player in the field, there are several Icelandic companies offering DLRs to schools on a commercial basis. One of them, the School Web (IC3), runs one of the largest websites in Iceland, measured in content as well as in unique number of visitors. It began as a user-generated innovation in the late 1990s with grants from Government funds to scale-up the development of a website of curriculum-related materials produced by teachers and shared with others, similar to curriculum provision planned for the Gateway (IC1). At the moment, 98% of the compulsory schools in the country subscribe. The original business case had teachers as the main clients, with the strap line "for teachers – by teachers", as the three founders were all teachers, but the service is increasingly targeting parents. Parents become aware early on of the site's existence, since almost half of the kindergartens subscribe to the service. No pilot site was made, but the incrementally added content is usually piloted with teachers before it is made generally available through the site. These teachers belong to a small set of pilot schools that the editors have established a long-term relationship with.

Another smaller Icelandic company, called Rasmus, bases its business model on trust – schools are free to use their website and the materials available there but are asked to pay for their use. The limited size of the country and the education sector probably makes the social control stronger, and thus makes it possible to run a company based on a customer trust model.

More examples of user-generated innovations can be found in Iceland with three cases in the area of language learning – one related to foreign language learning in compulsory schools in Iceland (the Language Studio [IC4]), another to the study of Icelandic for immigrant students (the Katla

Web [IC5]), and the third aiming to help young expatriate Icelanders to keep up their mother tongue while abroad (Ice-Kids [IC6]). The rationale for all three cases is to use technology to improve the quality of language learning and extend this curricular option available to learners. The primary activity for the award winning Language Studio is to develop, provide and disseminate DLRs to students all over Iceland. The Studio makes extensive use of a web-based message board and web-based resources, of its own creation and, to some extent from other sources on the Internet. It originated in a project from the late 1990s and was formally established in 2002. Schools with learners using the service must pay a basic rate and a fee per learner. The Katla Web was initiated in 2002 and the first website was launched in 2004. It has been developed using several smaller grants from national and local level, as well as funding from private companies. The web holds printable PDF files available to subscribers only. It has been restructured as a private company with no external funding and, so far, has few subscribers. Ice-Kids was built up from a wish to develop an Icelandic Learning Management System at the Iceland University of Education. Out of this, the idea grew to provide a web-based service for Icelandic learners abroad with content, activities and a community. Stakeholders were the Ministry of Education, Icelandic families living abroad and a number of sponsors, including the Ministry of Foreign Affairs. But the project operated outside the national education system and soon failed to engage many of the stakeholders. As with the Katla Web, it is unclear at the moment what the future will look like for Ice-Kids.

Scale-up of user-generated innovations

In contrast to innovations in other areas of the education sector, scale-up can happen very fast with DLRs. Small initiatives can grow rapidly and have a system wide impact without large-scale implementation efforts. The marketing of Lektion.se (SE4) has almost exclusively been done by word-of-mouth from teacher to teacher. Incrementally Lektion.se has enlarged its services to include a link library where peers exchange useful links, and a demonstration platform for materials from educational publishers and government agencies. The initiative has not received any funding from national or governmental authorities. In order to sustain and have resources to develop the initiative, Lektion.se now accepts advertisements related to school issues (teacher jobs, advertisements from textbook publishers, etc.).

The Finnish Peda.net (FI2) has scaled up operations in a similar fashion as Lektion.se. The web tools offered have changed over the years and the number of subscribers has grown. In 2006, 75 municipalities subscribed and there were more than 64 000 portals or platforms for collecting and distributing materials including 3 000 magazines made by students and teachers.

The first two years of development of the School Web (IC3) relied heavily on government grants. The site has grown rather slowly, if steadily, with the bulk of material being provided by contracted teachers and then finalized together with the editorial staff (and test users, as necessary). This has meant that the transition from html and PDF-files to multimedia has benefited from the drop in hard disk prices, so that the company development has not been constrained by investments in expensive Web service technology.

Of the other three bottom-up cases from Iceland, the Language Studio (IC4) seems to have been able to expand its number of services and users the most. The other two have encountered difficulties in the scaling-up of their activities and, at the moment, both of them are in limbo without, or at least very limited, public funds and few users.

Governments and the EU usually do not fund bottom-up cases for any longer period. They provide seed money and expect projects to find a "business model" that works in the long run. Most of the cases in this study seem to have managed this process. Most of them have turned into small commercial companies and opted for a sales' model. One exception from this rule is the teacher initiated and driven community Lektion.se (SE4), which, so far, has not attracted any external funding. Instead they have chosen to finance their further development and growth by advertisements. Of course, there might be a number of examples from each country of innovations which failed to find or develop a funding regime that made them sustainable. During the visit to Iceland of the team of OECD experts, at least two of the cases mentioned difficulties of this kind (Katla Web [IC5] and IceKids [IC6]). In these cases, as well as in the case of Lektion.se (SE4), the teacher innovators were "forced" to find commercial solutions, although they did not really see themselves as business entrepreneurs.

DLRs as user-created content

The scaling-up of DLR innovations can be done in two ways: by enlarging the number of products or services on offer, or by increasing the take-up within the target group or the number of target groups. One question that can be asked is whether it is easier to scale up a radical or an incremental innovation, but cannot be answered on the basis of the data available in this study. A similar question is whether it is easier to scale up a top-down or a bottom-up innovation. Different strategies can be found among the cases in this study. One way for an innovation to enlarge its offer, *e.g.* the number of available DLRs, is to invite the users to contribute with content. User-created content (UCC), which is sometimes also referred to as user-generated content (UGC), entered mainstream usage during 2005. It is used for a wide range of applications. OECD (2007b) proposes three central characteristics identifying UCC:

- **Publication requirement**: While theoretically UCC could be made by a user and never actually be published online or elsewhere, the focus is often put on work that is published in some context, be it on a publicly accessible website or on a page on a social networking site only accessible to a selected group of people (*e.g.* fellow students). This is a useful way to exclude email, bilateral instant messages and the like.
- **Creative effort**: This implies that a certain amount of creative effort was put into creating the work or adapting existing works to construct a new one; *i.e.* users must add their own value to the work. The creative effort behind UCC often also has a collaborative element to it, as is the case with websites which users can edit collaboratively. For example, merely copying a portion of a television show and posting it to an online video website (an activity frequently seen on the UCC sites) would not be considered UCC. If a user uploads his/her photographs, however, expresses his/her thoughts in a blog, or creates a new music video this could be considered UCC. Yet the minimum amount of creative effort is hard to define and depends on the context.
- **Creation outside professional routines and practises**: User-created content is generally created outside professional routines and practices. It often does not have an institutional or a commercial market context. In the extreme, UCC may be produced by non-professionals without the expectation of profit or remuneration. Motivating factors include: connecting with peers, achieving a certain level of fame, notoriety, or prestige, and the desire to express oneself.

While at least one of the national portals has opened up for UCC, most of them have not. In Utdanning.no (NO1) UCC can be found side by side with government funded and produced materials. All resources are marked with the name of the author and producer and whether the materials have had any quality check or not. The Course Hub (SE2) also uses UCC to some extent. In the case of Iceland, the Ministry chose to spin off the day-to-day operations of the national educational portal, the Educational Gateway (IC1), to a private company. One reason for this was to allow for more flexibility in the type of content included on the Gateway, as inclusion on a portal run by a private firm would not be seen as official material from the Ministry itself (unlike, for example, content created by the NCEM [IC2]), while the link to the formal school sector in Iceland remained prominent. (Iceland Country Case Report) An interesting example of how UCC can be promoted and used is the Norwegian Digital Learning Arena (see Box 6.1).

Looking at the bottom-up cases, Lektion.se (SE4) builds its whole strategy on UCC. From the beginning it only had content created by teachers.

Currently publishers can also publish materials for free as show cases in a special section. But still, the overwhelming majority of content comes from teachers. The Icelandic bottom-up cases (IC4, IC5, IC6) have, so far, not opened up for users to submit or share content. The same is true for the publishing companies (The School Web [IC3], Aschehoug [NO3]) that participated in this study. Although the evidence base provided here is rather thin, this points to the conclusion that UCC is not much used in the school sector in the Nordic countries despite the fact that this is a rapidly growing phenomenon on the Internet with a number of new business models emerging (OECD 2007b). OECD (2007a) examined Open Educational Resources in higher education, which to a large extent is UCC. OER hubs like MERLOT, Connexions, and LabSpace at OpenLearn. are examples of repositories building on UCC for the tertiary education sector. The same kind of international exchange platforms for schools are rare. The MELT portal, developed by the European Schoolnet with EU funding, providing more than 30 000 learning resources and 100 000 learning assets to schools.[1] But it cannot be considered as a user-generated initiative in its initial stage, although there are plans that the public version of the service (*http://lreforschools.eun.org*) will include UCC later in 2009. A better current example would be the Finnish based LeMill[2] – a community of some 5 000 teachers focused on finding, authoring and sharing DLRs. One obvious reason for this is that school education is less international than university education – students are younger and not as mobile as university students, the language of instruction is primarily the national language, and the curriculum is national. Although the national agencies are slower to implement UCC features in their portals there seems to be a willingness to do so and progress in this area will probably be visible soon.

To summarise, scaling-up of DLR innovations can be done either by enlarging the number of products and services on offer or by increasing the size of the target group or adding new groups. To make use of user-created content (UCC) is one way to increase one's content, a method very much in line with Web 2.0 tools and how the Internet is changing. There are examples both of top-down and bottom-up cases making use of UCC, but the cases are still rather limited in number. An important aspect of scale-up is the question of sustainability. The bottom-up initiated innovations have developed different funding or business models in order to sustain their activities. Most of them have turned into commercial companies, although this sometimes was not wished for by the innovators.

Box 6.1. **Norwegian Digital Learning Arena (NDLA)**

In 2007 the Norwegian government decided that students in upper secondary education should be provided with free educational materials. The county municipalities will be responsible for distribution of both printed and digital learning resources to students. In 2006, the Ministry of Education and Research allocated EUR 5.46 million to projects related to the development of DLRs in upper secondary education. This funding was also meant to prepare the ground for the introduction of free learning resources. In 2007, The National Digital Learning Arena (NDLA) was established, an inter-regional initiative whose main objective is to support the county municipalities in their work relating to DLRs and to secure the quality, quantity and accessibility of DLRs in upper secondary education.

NDLA has received EUR 2.84 million in grants to develop DLRs for the syllabus in first grade in upper secondary level. The Ministry of Education and Research has decided that 40% of the funding for NDLA goes to purchasing of DLRs in the open market. The remaining funds go to teams of teachers who will produce new DLRs, organized by NDLA. All materials will be scrutinized by university experts before publication. Inspired by the Open Educational Resources movement, all materials will be available under Creative Commons licenses for free on the website of NDLA as well as on the national portal Utdanning.no (NO1). By summer 2009, NDLA will also open a repository for teachers to submit and share DLRs.

Source: Erstad, Silseth and Dalaaker (2008), Metamatrix (2007) and *www.ndla.no*.

Knowledge base, monitoring and evaluation

In Lektion.se (SE4) the innovators are technical autodidacts with long standing experience as teachers and close contact with colleagues. Thus, the initiative is built on the initiators' own knowledge and expertise. The monitoring is done on a daily basis and all materials are uploaded by the editors. So far, no formal evaluation has been done.

Since Peda.net (FI2) is run by a research team, there is a close relation to educational research and development. According to its website, the research team is looking at the potential of technology and virtual learning environments as support systems for learning and teaching. Its activities involve, on the one hand, multidisciplinary, theoretically oriented basic research and, on the other hand, development-oriented studies that spring from practical situations. The research activities around Peda.net represent development-oriented studies carried out in close collaboration with schools and teachers. In addition to the staff of different educational institutions and organisations, those contributing to this research collaboration also include other national and international experts active in the field.

As regards the School Web (IC3), the editors have adopted a set of criteria for establishing the link from new material to the national curriculum. The site material is seemingly enjoying high popularity, as witnessed by the large amount of subscribers and the successful business venture. Recently they have moved also into offline material, at the request of their users. Material is submitted chiefly by teachers and is subjected to editorial review and selection procedures. Approved submissions are paid for, providing the double incentive of a mark of quality as well as monetary reward. Some teachers work hard to further refine their material iteratively, using feedback from pilot schools and from the editors. Even if much of the material is fairly conventional in its approach, the procedure allows for more innovative pedagogy to reach a broad audience. The wide dissemination of the material is a bonus incentive for teachers, in that the pleasure of witnessing colleagues use their material in class is strong.

While formal summative evaluations of the impact of the Icelandic Language Studio (IC4) were not apparent, it is clear that there is a great deal of informal formative evaluation of the project by both Language Studio instructors and, to a lesser extent, learners. There is a form of market test for Language Studio services, as schools must sign on (and pay) for its services, and this presumably provides an important regular feedback loop.

Clearly the use of academic research has been rather limited. Also there are, as far as we know, only two cases used tacit knowledge during their implementation. It is also interesting to note that none of the user-generated cases in this study seem to have drawn on explicit professional knowledge.

Conclusions

The user-generated innovations presented here are all classic examples of a small group of enthusiastic and skilled teachers or researchers, working hard to make their idea successful.

Although several of them have turned into at least partially commercial companies (*e.g.* School Web [IC3] and Katla Web [IC5], Peda.net [FI2], Lektion.se [SE4]), this seems not to have been the driving force behind the innovation. At least some of the innovators stated during interviews that they would have been more comfortable to continuing their innovation with public funding. They did not look upon themselves as business entrepreneurs. Still, the fact that they succeeded in transforming their initiatives into businesses might become a driver for others. Thus a barrier to user-generated innovations would be created if the education system was not prepared to support or accept such a transformation for financial or other reasons. Education systems with publicly funded clearing houses, rubberstamping teaching materials for schools, might be less flexible in this matter.

From the policy point of view, questions of interest relate to what can be done to promote, nurse and nourish user-generated innovations. There seem to be a number of drivers that can be used in governmental strategies, such as:

- Provide funding for development projects. The drawback of project funding is that a lot of projects happen only because the funding is available, not because there is genuine demand for them. An alternative strategy could be to cluster funding offers like the European Commission sometimes does.
- Provide seed money, *i.e.* small amounts to develop a project idea, write a proposal and pitch this to existing funding agencies.
- Provide transition funding, to help keep innovations afloat once the initial project funding has ended but while people still need time and resources to experiment with different business models. An example of this kind of funding is what the European Commission used to call Accompanying Measures.
- Promote or develop national or international platforms for sharing results and findings partners. The French organisation PrimTICE, which has been set up to enable the identification, description, indexing and pooling of ICTE uses in primary education, is one example. The EU-funded project eTwinning is another example of a service for partner finding.
- Foster and encourage research and evaluation projects so that governments and government agencies as well as development projects or innovative business people can learn from others' successes and mistakes.

Moreover, the opportunity for innovators and entrepreneurs to launch disruptive innovations (Christensen and Horn, 2008) could be a driver of a slightly different kind. Opportunities to initiate disruptive innovations occur when established actors (in this case governments, government agencies and publishers) fail to see that there is a "market" for a different kind of DLR – a kind no one is offering at the moment. At least Lektion.se (SE4) and School Web (IC3) seem to be examples of disruptive innovations, offering products and services of a new and simpler kind than publishers or government agencies. Both present teacher-initiated materials – often not as sophisticated or well designed as materials from publishers. The School Web offers about 30% of its DLRs for free to anyone, not only subscribers. The business model of Lektion.se also builds on revenues from advertisements instead of sales to teachers or schools. A similar Swedish case is Skolporten.com, a company offering not DLRs but school related information and news for free on their website and through weekly newsletters. According to official statistics, from an independent statistical company, Skolporten.com has some 80 000

subscribers mostly from the school sector.[3] Subscription to the newsletter is free and the business model is similar to lektion.se – school-related advertisements complemented by other activities, such as organization of conferences. In terms of establishing themselves as players with impact on a systemic level, these three examples are truly successful.

A number of barriers to *bottom-up innovations* have been identified in this study:

- A possible barrier to bottom-up innovations is the unwillingness of teachers, schools, local or national educational authorities to accept and use bottom-up innovations, *e.g.* innovations lacking a quality assurance from the government or a government agency. Such unwillingness has not been detected in the Nordic countries. There are examples of bottom-up innovations from all five countries which play an important role in respective countries.
- One existing and harmful barrier seems to be a lack of overview of developments and mechanisms to help build synergies between them. A quote from the Finnish Country Case Report illustrates this point. The team of experts conclude that "[i]nnovation is certainly evident but is characterised by small, local projects and initiatives some of which fail to see the value in sharing their results via the available national portal. In a decentralised education system, better coordination is needed to enable cross-fertilisation and 'mash-ups' of innovations (increasingly necessary in a Web 2.0 world)" (Country Case Report Finland).
- Low use of existing DLRs, or low interest in new ICT developments by teachers, could be expected to be another barrier to innovation. Although most of the cases investigated in this study were developed without much previous demand from teachers or students, lack of demand would surely be a hurdle to innovation in the long run.

As already noted, the Empirica study (2006) investigates barriers to the use of ICT in terms of lack of access to computers and the Internet, lack of adequate content and lack of motivation. As pointed out in Table 3.5 (see "In-service training of teachers"), Denmark scores highest among the Nordic countries regarding the propensity among its teachers to take up ICT in their teaching. When the three components – access, competence and motivation – are looked at individually, the largest differences among the countries is found in motivation. Teachers in Iceland and Sweden, and to some extent in Finland, are much less motivated to use ICT than Danish and Norwegian teachers as well as European teachers in general (see Table 6.1). Reasons for this lack of motivation are not known but, irrespective of them, this deficiency can be expected to affect the use of DLRs.

Table 6.1. **Teachers' access, competence and motivation to use ICT**

	Access[1]	Competence[2]	Motivation[3]
Denmark	71.3	93.3	70.9
Finland	63.3	84.9	57.8
Iceland	58.8	88.2	29.4
Norway	68.1	90.9	72.8
Sweden	67.9	93.3	41.4
EU 25 + 2	60.7	82.0	68.4

1. The higher the value the greater percentage of teachers agree with the statement that their school is well-equipped.
2. The higher the value the greater percentage of teachers feels themselves skilled in using ICT.
3. The higher the value, the greater percentage of teachers are motivated to use ICT.

Source: Benchmark Access and Use of ICT in European Schools 2006, Empirica (2006).

One might speculate if there are virtuous and vicious circles in play – in countries where governments have showed a long term interest in promoting the use of ICT in education, in terms of government policies and programmes, and participation in international studies in ICT, there seems to be from the side of teachers a high interest or motivation in using ICT in general and DLRs in particular. It could also be expected that there is a growing demand from teachers for a continuous political support and for more and better DLRs. Hence a virtuous circle is created. *Vice versa* – in countries with weak political interest, in terms of unclear policies and few programmes, teachers might be expected to have less competence and less motivation to use DLRs. The vicious circle means that the demand for new ICT policies and programmes, as well as for DLRs, is probably weaker than in other countries. The recommendations in Chapter 7 look at ways to break such vicious circles.

Notes

1. *http://www.melt-project.eu/Melt-Portal/Index.iface?rvn=1.*
2. *http://lemill.net/front-page.*
3. See *http://ts.se/Public/CirculationNumbers/EmailCertificateList.aspx.*

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Chapter 7

Conclusions and Recommendations

This chapter presents a set of conclusions and policy recommendations for governments and government agencies drawing on the empirical and analytical findings of the project discussed in this report. It is worth pointing out at the outset that these conclusions and recommendations relate to both the production and use of DLRs in schools but also, more generally, to the study of systemic innovation in education.

Conclusions

- **Successful ICT-based innovations spread fast.** Favourable economic and technological conditions make hardware and software for innovations available to almost anyone. This, in turn, means that individuals or small groups of people, in this case teachers or researchers, can create innovations with a systemic impact. There are at least three examples in this study where small groups of teachers or researchers have initiated innovations which have scaled-up and become well known and much used innovations on a national scale because the end-users have seen the relevance of their use.
- **It is difficult to plan for scaling-up ICT-based innovations: the end-user decides.** To some extent this has to do with the fact that scaling-up web-based DLRs might be just as much a matter of diffusion as a planned activity of distributing information about the innovation. Once a DLR is published on the Internet, the innovator has limited possibilities of controlling the diffusion process. Also the scaling-up in the case of DLRs seems to be closely related to sustainability. Without a viable funding or business model, DLR innovations will not scale up.
- **Limited or non-existing academic knowledge does not seem to act as a barrier.** The use of academic knowledge has so far, been different in the field of DLRs compared to many other fields of education,

in the sense that there has been a lack of critical mass of codified, academic knowledge in the area, partly due to the novelty of the technology itself. When the Internet was first used in Nordic schools, the base of academic knowledge was weak which resulted in a much peer learning and policy borrowing between senior officials across borders. This exchange and sharing of informal knowledge therefore enabled the initiation of a number of successful innovations. The same is true regarding the involvement of stakeholders. The limited involvement of stakeholders seems not to have created resistance to using DLRs. Instead of using pilots, incremental development models were adopted.

Policy recommendations

As discussed earlier in this report, governments can take different roles in innovation, such as creating favourable conditions, fostering innovation, or being leaders of innovation. They often take several roles at the same time depending on the perceived needs and the political interest in promoting innovation in the area in question. The literature on innovation in education (*e.g.* Fullan, 1982; Atkin, 1998; Uys *et al.,* 2004) has concluded that, in order to have a healthy innovation climate, a country needs innovations coming both from governments and from users – from the top as well as the bottom. As a result, governments might want to assume all three roles described above in order to ensure that innovation happens. The policy recommendations discussed in this chapter focus on these three roles.

Creating enabling conditions for innovation

Governments and their agencies can help indirectly the development and use of DLRs by setting up enabling conditions, such as:

- **Establishing a coherent vision on and strategic approaches to digital competence.** Related to this is the issue of integrating digital competence as an element in final exams and assessments in compulsory and upper secondary schools.[1]
- **Making publicly funded information freely available** for commercial and other use of the materials in new ways, to create mash-ups as well as other innovations. Publicly funded materials should be publicly shared.
- **Joining up innovation, for example through the promotion of dialogue fora for stakeholders**. In some countries, significant innovation is taking place, but too often in isolation. Research groups are unaware of what colleagues in other parts of the country or in

related fields are doing, entrepreneurs lack input from research, schools are also working with a silo mentality. Momentum could be gained and resources saved by more cooperation and better contacts. Governments and government agencies could play a vital role in establishing arenas or platforms for exchange of ideas, contacts and knowledge. The Danish practice of an informal meeting platform known as the "Coffee Club", in which stakeholders from the sectors of education, local and national government and industry informally discuss and exchange views and ideas, could serve as a model.

- **Supporting the building up of a formal knowledge base.** The existing academic knowledge base on DLRs is growing but still weak and the use of explicit knowledge in innovation has been feeble. Large investments have been made in ICT in education in the belief that "ICT can make a significant contribution to teaching and learning across all subjects and ages, inside and outside the curriculum" (DfES, 2003). The evidence to support this belief needs to be strengthened and more evaluation and research needs to be applied to understand how DLRs can be best designed to serve different needs, and under which conditions different DLRs should be used. Further the exchange of informal, practitioner knowledge should be supported, particularly as it has been so instrumental so far in getting DLR innovations off the ground. One way of facilitating the exchange of such knowledge is through the establishment of dialogue fora (see above).

Some aspects of creating favourable conditions are related to the use of DLRs. With growing use and a growing demand for DLRs, more favourable conditions for investments and innovations would be at hand. In the Nordic countries, some of these actions would be the responsibility of teacher training institutions and local educational authorities. Governments should:

- **Facilitate access to DLRs** and help schools and individual teachers to find and evaluate existing DLRs, both commercial and non-commercial, by promoting, federating or setting up archives or repositories where both commercial and non-commercial players can display their DLRs, such as the Danish Materialeplatformen.
- **Provide support services to facilitate access and use,** such as the Danish Uni-login which facilitates use by reducing the number of passwords and relieves publishers of the burden of ensuring that individual teachers and students are entitled to use the DLRs. The Norwegian NORLOM, which is a standard for Learning Object metadata (LOM), adapted to the Norwegian education system, is a comparable service which enables both publishers and teachers to tag their resources with relevant metadata in order for others to easily

find them. Furthermore, a growing number of European Ministries of Education are using the European Schoolnet LRE LOM-based application profile and adapting this to their national requirements. By so doing, interoperability not just Nordic but at European level is significantly enhanced.

- **Promote DLR design and use by teacher training institutions, both for initial and in-service training.** Teacher training institutions should include knowledge on how to use and evaluate DLRs as part of their training. There is a need to raise awareness of teachers and student teachers regarding when, how and why one could and should use DLRs rather than printed textbooks or other learning materials. Teacher training institutions should also offer in-service training for teachers in the use and evaluation of DLRs.[2]

Local educational authorities and schools should provide incentives for teachers to use and produce DLRs. This can be done by:

- **Increasing the awareness among teachers** of the existence of Open Educational Resources (DLRs available for free) as well as existing commercial DLRs and encourage their use; this takes less skill than producing digital resources, but it will make it more likely that, in the long run, teachers will refine those resources.
- **Initiating and maintaining a public debate** on when, where and why schools should invest in DLRs as well as in printed textbooks.
- **Investing in training on fair use** for teachers and school managers. Training should be offered to teachers and school managers on the use and production of DLRs and on copyright law. Schools wanting to foster the use and production of DLRs should stress the importance of compatibility – meaning, not only the use of open standards and open source software in production and dissemination of learning resources, but also licenses that make resources compatible with other resources and easier to reuse.
- Valuing DLRs use for teacher professional development. Making teaching portfolios or similar requirements part of or at least optional for the recruitment process and the production of DLRs part of the requirement to document excellence in teaching.

Fostering innovation

Governments might also more directly foster investments and stimulate the production of DLRs both by commercial companies (publishers) and users.

- **Supplement seed money with development and transition funds.** Production of DLRs can be stimulated by offering seed money as: public tenders in the case of publishers; as development project funding and transition funding to help keep innovations afloat once the initial project funding has ended and people need time to experiment with different business models. An example of the latter kind of funding is what the European Commission used to call Accompanying Measures.
- **Promote cooperation between public and private players for DLR development.** So far, there is not much of a tradition in the Nordic countries of cooperation between public and private players in the educational sector. Governments can both promote and try to push companies to develop corporate social responsibility programmes and thus increase the cooperation with public authorities in the educational sector. Schools and local educational authorities would need guidelines to help them approach these issues in a responsible way.

Being leaders of innovation

- It is important to consider the relative circumstances of each country when deciding whether to act as a leader of innovation instead of supporting initiatives of others.
- When acting as leaders of innovation, governments need to rethink their role in relation to communities of teachers and user created content (UCC). So far, government initiated innovations have used a "broadcasting" or "delivery" strategy and developed a number of DLRs and services without much consultation with the users. The strong trends of user involvement on the Internet, *e.g.* through Web 2.0 applications, will increase the need for involving the views of teachers and the development of UCC. National portals and other government initiated innovations will therefore need to move away from a "delivery" towards an "engagement strategy".

Notes

1. See *http://www.atc21s.org/default.html*.
2. CERI has an ongoing project on the use of ICT in initial teacher training. See its dedicated website at *http://www.oecd.org/edu/nml/itt*.

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Chapter 8

Developing the Knowledge Base on DLRs

This chapter looks at ways of strengthening the knowledge base on DLRs. It starts by outlining what kind of research will help develop the knowledge needed to promote the further use and development of DLRs. It also suggests a conceptual framework for creating a system of indicators related to the development, use and effects of DLRs. Finally, it sketches out some embryonic scenarios on new ways of producing, distributing and using DLRs.

The research agenda

This study has explored some of the issues related to DLRs as systemic innovation, but since much remains to be known about this subject, the research agenda could be lengthy. Most pressing is to learn more about the effects and effectiveness of different policies so that an innovative climate affecting the entire educational system can be created and sustained. The research by Kozma (2003, 2008) and Lee (2003) concerning policies on ICT in education provides a particularly good starting point, but further refinements are needed in order to clearly define the role of DLRs in the educational system.

There is also a lack of knowledge regarding the effects and effectiveness of individual DLRs on learning outcomes and learning strategies – how could a learning resource be designed and used so as to have optimal effect on different kinds of learners? This ties in with the discussion by Drotner (2006a, 2006b) regarding research on textbooks (and learning materials in general) and the need for dialogue among researchers in pedagogy/didactics and in ICT. The design of DLRs dealing with new interfaces, such as haptic interfaces, and how they can be used by different learners is another area in which more knowledge would be useful, as is the promising area of game-based learning, although the latter is still in its infancy.

One way to arrive at a research agenda which would establish how different issues in research traditions relate to each other is to look at needs, production, distribution, use of DLRs and the assessment of student learning outcomes: what might be called the "DLRs process". Table 8.1 below suggests what such a research agenda might look like.

Table 8.1 is by no means exhaustive but instead highlights the kinds of issues currently at hand. It should be noted, too, that there is a need not only for theoretical research, but also for development – the "D" in "R&D". Further, during the course of this study it has also become clear that there is a need to take stock of the existing supply of DLRs and their use by teachers and learners in different age groups and curriculum areas. Hence, the OECD working group on benchmarking and assessing the impact of DLRs is of great importance; its proposed work is outlined in the sections that follow.

Table 8.1. **Research issues related to the DLRs process**

Needs analyses	Production	Distribution	Reception/Use	Assessment of learning outcomes
What are the new challenges in learning and how can they be tackled with ICT and DLRs?	Design of DLRs	IPR issues	Learning styles and modalities and degrees of interactivity – which DLRs for which learning style	Studies in what and how we learn in ICT-enhanced environments
Mapping of needs of DLRs for learners	Metadata	Distribution models	Didactical research – use of DLRs in different curriculum areas	Methodologies for evaluating and assessing knowledge in relation to new kinds of DLRs
Mapping of needs for DLRs for teachers	New interfaces, e.g. haptic interfaces Size and sequences of LOs Relation to LMS, SCORM, standardisation issues Production models for different types of DLRs	Licensing and business models	Quality assurance mechanisms Models for teachers to evaluate DLRs	

Benchmarking the use of DLRs

The comparative study of ICT in school education has focused primarily on investments in infrastructures, equipment and the resulting ratios per pupil, as well as on in-service teacher training and, lately, the incentives and barriers for classroom use. Less attention has been paid to the development and publication of DLRs as a means to increase the added value that ICT could bring to teaching and learning. In some countries, governments have started to subsidise programmes, repositories and networks focusing on DLRs. However, until now, little empirical evidence exists on the dimensions and impact of these policies, including in particular their capacity to foster the development of DLRs and their final effects on the teaching and learning processes.

Among the final outputs of this study is the delivery of a conceptual framework for the creation of a system of indicators related to the development, use and effects of DLRs. This initial proposal, whose basis was first discussed in a project meeting in September 2007, is intended to nurture the discussions of the standing working group in this area and to shed more empirical light on the theoretical and policy debate about the effects of technology-enhanced learning.

The policy background

Based on expected benefits from using ICT in education, significant government investments have been made in most OECD countries. Between 1998 and 2002, ICT expenditure in England almost doubled in secondary schools and multiplied by three in primary schools. Equally, ten years ago, the OECD already reported that education policy makers saw enormous potential for ICT to transform education. In 1999, the limited available data on trends in ICT investment and use were headed sharply upwards (OECD, 1999). Around that time an OECD conference warned about the urgency of "bridging the digital divide" (OECD, 2000). In 2004, PISA data confirmed the exponential growth in the presence of ICT in education (OECD, 2004). In just three years, between 2000 and 2003, student-per-computer ratios dropped by more than half in most countries (and by a factor of 4-5 in those that were lagging). While less than a third of secondary schools had Internet access in 1995, by 2001 Internet access was virtually universal. Although there are no internationally comparable data on current educational ICT hardware and software expenditure, there are signs of unmet demand for additional investment, particularly in the areas of hardware upgrading and the availability of digital content or learning resources. According to the most recent PISA data, school principals cite a lack of adequate computer software for instruction as an important hindrance to science instruction (OECD, 2007).

Recently, a number of studies have aimed at analysing the impacts of ICT in education. The analytical work undertaken by SITES, E-Learning Nordic, and BECTA, as well as the OECD's PISA reports (2006 and 2009, currently underway), represents the main experiences in the field. However, so far there seems to be little conclusive empirical evidence regarding the benefits associated with ICT use in schools and their impacts throughout the educational system, and claims of "unfulfilled promises" have opened an academic and policy debate about whether the considerable investment in ICT has payed off in any obvious way.

Objectives of the conceptual framework

The overall aim of the conceptual framework is to bridge this analytical gap in the study of DLRs and deliver a conceptual framework for developing indicators that could trace and benchmark the development, use and effects of DLRs.

More precisely, the objectives of this proposal are:

- To provide a holistic conceptual framework for the development of these indicators. This model would map the different factors affecting the development and use of DLRs, and their impacts on the educational system.
- To define and construct a number of key indicators that would allow comparison and benchmarking across different countries of progress in the production, availability, use and impacts of DLRs in schools.
- To identify the existing relevant sources and collect the available data. Based on the different factors described in the conceptual framework, to identify what data are already available in different data sources and the possibility (or not) of linking different datasets.
- To highlight possible options for generating the missing data. As a result of the analysis of the data already available, data gaps will be identified, and different strategies and tools to develop the required data will be suggested.

Definition of the conceptual framework

While there is a clear and practical interest in tracking the availability and use of DLRs, there is an even greater interest in understanding the causes driving the development and use of DLRs and the impacts on teaching and learning that they generate. The lessons learnt can be used to refine our understanding of the incentives and barriers regarding the broader use of ICT

to enhance school education. An analytical framework capable of identifying and explaining these factors, their interrelations and their impacts would allow analysts to deepen their knowledge about the use of DLRs – and more broadly, ICT – and provide evidence-based policy recommendations for policy makers.

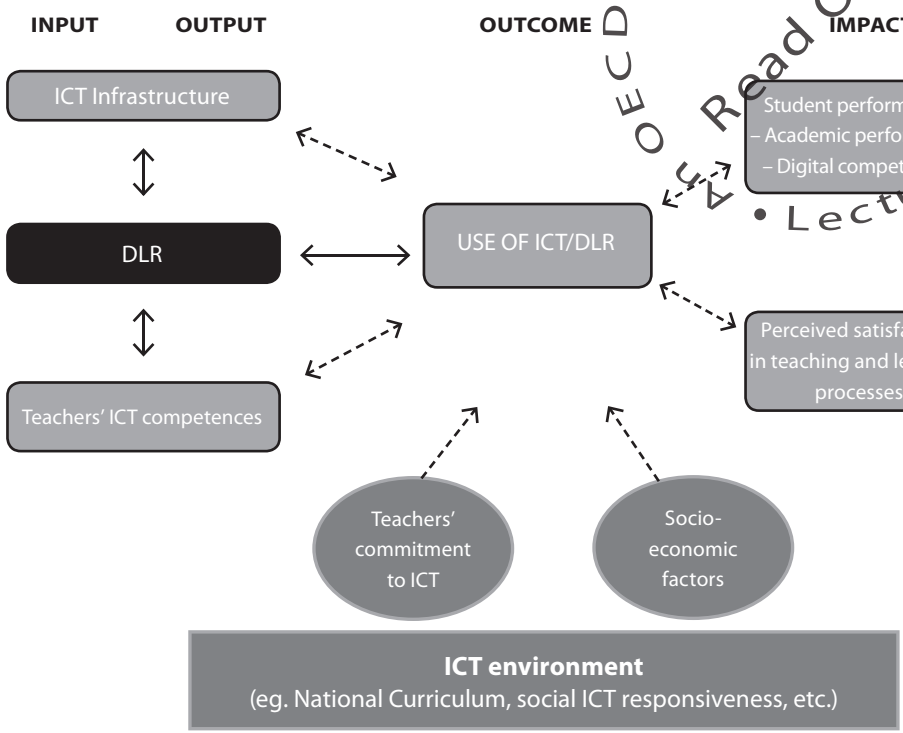
However, at the moment there is no holistic conceptual framework that takes into account all the intervening factors and their possible interrelationships. This lack of available data has prevented the development of more robust results that would allow stakeholders to monitor and evaluate the role that different sources of ICT investment (including investments in DLRs), play in the use of ICT and on the teaching and learning processes and the educational attainment of students. This lack of empirical evidence has also affected the necessary political support for eventual further investments and has increased the feeling among stakeholders of "unfulfilled promises" related to the use of ICT in the educational system.

In light of the information gathered in the present project during the interviews conducted with a number of stakeholders (*i.e.* Departments for Education, teachers, head teachers, students, local and regional governments, and publishers) and a review of the existing literature on comparative research and recent practices, an analytical framework is proposed. This framework aims to account for both the factors affecting the development, use and impacts of DLRs, as well as for the complexity of the interrelationships between these factors. Figure 8.1 presents a visual representation of this framework.

The proposed model presents a number of investment measures on the left-hand side of the chart that are interrelated. Each of these investments produces a specific output in the form of available computers or internet access (for the case of ICT infrastructure), digital learning resources or enhanced teachers' ICT competencies. The combination of these outputs would influence the actual use of DLRs, and ICT more broadly, in a particular moment in the educational system. However, rather than claiming a linear and causal relationship, the model intends to reflect the complex nature of the interaction between each of these factors and the actual use of DLRs and ICT more broadly. For instance, higher levels of DLR or ICT could also stimulate higher levels of ICT/DLRs investments.

In addition to these three main direct investment variables, a number of "environmental factors" would also affect the levels of DLRs/ICT use and therefore should be included in the model. These variables relate to the overall ICT environment in the country that may push for or against the use of ICT in society in general, and in the educational system in particular. Particular attention has to be paid to the fact that very different factors can be brought into the picture. The influence of public policy on these factors

Figure 8.1. **Analytical framework for assessing the development, use and impacts of DLRs**



could differ both in scope and impact depending on the nature of these factors. Teachers' commitment to the use of ICT in classes for example, is a key variable that affects the final use of DLRs or ICT in schools, and that would be the result of a mixed of factors such as policies to promote ICT in schools and the teachers' attitudes and convictions regarding the role of ICT in the teaching and learning processes. Pupils' expectations would be another variable that could significantly affect the use of DLRs and ICT and that could be far from being affected by public intervention. These factors are somehow the "soil" where the DLRs/ICT investments are "seeded" and that could be determinant in obtaining the desired "fruit".

As a result, policy makers are confronted with a policy dilemma in terms of what to do: invest in infrastructure, DLRs, teaching competencies (in which ones, and how much?) and/or in improving the ICT environment (how,

and how much?) in order to obtain the desired results in terms of enhancing the ICT/DLRs use.

Finally, the model suggests that the use of ICT/DLRs could have a final impact on the educational system by allowing students to achieve higher educational attainment, developing stronger digital competencies and improving the perceived satisfaction in the teaching and learning processes. These potential benefits need to be assessed and the connection to the use of DLRs, and ICT more broadly, well established. The causal relationship between the use of DLRs or ICT and the final impacts has not been able to be established yet, partially due to the lack of available data, and partially due to the complexity of the impacts and the numerous factors that may influence them. Again, the relationship between the variables may not be unidirectional and, therefore, higher levels of technological competence, better academic performances or higher levels of satisfaction in the teaching and learning processes could also influence higher ICT/DLRs uses, triggering a virtuous upwards circle that would move within the whole model.

The relationships between the different variables in this model are hypothetical and their existence (or non existence) should be investigated empirically, should data become available.

Definition of the variable in the conceptual framework

The model described above presents a number of variables and hypothetical relationships between the variables that need to be tested. This section presents briefly the different variables. As it will be presented, this section only identifies the variables and provides some initial suggestions for their definition and measurement. The difference in scope of these definitions would therefore affect the type of data that would be required. These variables, classified according to their nature and role in the proposed model, are:

Direct investment variables

Direct investment variables are the different sources of investment where a clear connection between the initial investment and the actual results accruing from them can be identified. The model identifies three investment types, closely intertwined:

ICT Infrastructure: This variable deals with the investment in equipment (computers, whiteboards, laptops, projects) and network connections. A number of clear outputs can also be observed as a direct result of these investments: the number of computers per students, or the number of computers with (broadband) internet connection per student, are just a few examples of this type of variables.

Digital learning resources (DLRs): In this report DLR refers to any digital resource used by teachers and students for the purpose of learning. Moreover, it is important to note that this definition and measurement would be a stricter approximation of the overall DLR concept and therefore any conclusions about the availability and role of DLR should be handled very carefully.

Teachers' ICT competencies: This variable relates to those investments aiming at making teachers more competent and positive towards ICT and using ICT in school. The input investment would be the resources devoted towards teachers' training and ICT. The output measure, however, could differ and allow for different definitions and measures. On the one hand, an easy and direct measure could be the number of teachers trained in the system. On the other hand, a more complex measure could relate to the attitudes and changes in attitudes of the trained teachers towards the use of ICT/DLRs.

Outcomes

An intermediate outcome can be linked and traced back to the initial investment variables, but can be also influenced by some external factors.

Use of ICT/DLR: The amount and nature of the different uses of DLRs and ICT. This broad variable could be broken down in different categories and create a typology of different type of ICT/DLRs uses according to the different categories of DLRs, for example. Equally, a classification of the use by subject and class group would also provide more information that could be useful when analysing its relationship with the investment variables.

Impacts

Impacts are the final objective that the initial investments aim at. The model identifies two main types of possible impacts:

Student performance: The use of ICT and DLRs could have an impact on student performance that could go in two directions:

- The development of the ICT competencies (or "21st century competencies"): The definition of ICT competencies could be restricted to the effective use of the ICT infrastructure, *i.e.* use of a computer or the Internet, or it could have a broader scope, where students would be able to use, search, understand and even produce different content in a digital form in order to get or show a better understanding of particular subjects. In the latter, specific definitions of competencies should be developed and appropriate tests should be in place in order to measure and evaluate the achievement of these competencies.

- The academic performance in basic subjects: The use of ICT in learning different subjects could have an impact on the actual academic attainment of students in these different subjects. Analysing these results and comparing them before and after the use of ICT/DLRs would be important to establish an eventual causal relationship between the two.
- Improved or new teaching and learning processes: The use of DLRs and ICT could also improve or bring about new processes of both teaching and learning, making it more interesting for students and teachers, enhancing their motivation and improving the communication between the different stakeholders. Having an "objective" measure of "improved" processes could be very difficult, as it would require a clear definition and measurement of all the different aspects affecting the processes, including the always fuzzy concept of quality. However, a "subjective" measurement of changes in processes by the different stakeholders could be a way to get around this initial difficulty.

Environmental factors

These variables, although they cannot be directly controlled by direct government investment, have a very clear impact in the capacity of the direct investments to achieve the desired results. They are "the soil" where the different investments ("the seeds") are planted.

Teachers' commitment to ICT: Teacher commitment and determination to use ICT and DLRs in their schools is one key variable that may explain differences in the levels of investment in schools and also in the actual use of ICT/DLRs by the teachers. This is particularly true in decentralised systems, where teachers have considerable autonomy. Also, research has shown the relevance of leadership in schools in this domain.

Socio-economic factors: Socio-economic background, age and gender of students have been pointed out in the literature as being a key factor that may influence, not only t learning expectations, but also the degree and scope of the actual use of ICT/DLRs (outcome variable), and also influence decisively student educational attainment (impact variable) Therefore, any study that aims at drawing causal relationships between variables should take these factors into account.

In addition to these variables, it is important to note that the model also identifies a very broad variable that somehow affects all the different variables in the model, the *overall ICT environment*. This variable aims at explaining the overall societal attitude towards the use of ICT, not only

in educational systems, but more broadly in all aspects of life. This broad variable would include:

ICT responsiveness: ICT readiness and acceptance in the overall society influence the pressure and demand for the inclusion of ICT in the educational system, as well as the attitudes of both teachers and students towards the use of ICT. Possible measures of this responsiveness could be the penetration of ICT in homes, students' lives or in firms.

National curriculum: The inclusion in the national curricula of the obligation to use ICT/DLRs, in students' matriculation, examinations, either directly or indirectly (by way of mentioning them in the definition of expected pupil competencies) may be a variable that may explain difference across countries in the use of ICT/DLRs, and also may be a factor affecting the levels of ICT/DLRs investments in the educational system.

Next steps

The main activities that should be carried out are:

- **Redefinition and refinement of the model**: A validation of the model should be carried out. More precisely, this activity would (re-) define and identify new factors, map the hypothetical relationships between the variables, and revisit the scope of the model. This refinement of the model would allow building the necessary consensus in order to develop internationally agreed and comparable indicators.
- **Redefinition of variables**: Alternative definitions for the variables are available, with differences in scope and nature. A commonly agreed re-definition of the variables would then be necessary.
- **Evaluation of available data**: Based on the agreed model, an evaluation of the existing data sources and the possibility of linking different datasets in a coherent manner should be carried out.
- **Data needs assessment**: Based on the agreed model and the data already available, a data needs assessment should be carried out. As mentioned in the definition of the variables of the conceptual model, the data needs can be defined in different levels of depth. The complexity and cost to obtain the data should match the utility and a consensus decision should be taken in defining the variables and in developing the necessary methods to obtain the required new data.

Looking at the future of DLRs

In the information society it is important that people can use ICT and digital media in working life as well as in their role as citizens and during leisure time. Technological development creates new opportunities for learning, both in and outside of schools. Young people need to be digitally competent and most often it is expected that the school will furnish young people with the skills needed. To do this, schools need to use and work with different kind of digital tools, not least in the form of DLRs.

Furthermore, what used to be a rather stable setting with fixed roles – educational policy makers setting the scene for learning through curricula; educational publishers developing the learning materials building on the curricula; and schools implementing the curricula issued by policy makers and using the textbooks produced by publishers – is now changing. New actors like media companies, broadcasters, computer game developers, international publishing houses, and software developers are moving in. Teachers are producing and sharing DLR on an unforeseen level. Students are using DLR and digital tools they find for free on the Internet both during and after school hours, often challenging what the teacher and the school offers. At the same time, new digital divides are emerging, this time dividing those who can master the flow of information, sift, digest and use it and those who are unable to protect their integrity on the Internet and get lost in the new digital landscape. Education policy makers need to respond to these challenges.

The annual Horizon Report (2009) describes "the personal web" as one of the strong trends in higher education within the next two-three years. The personal web means that "computer users are assembling collections of tools, widgets, and services that make it easy to develop and organize dynamic online content. Armed with tools for tagging, aggregating, updating, and keeping track of content, today's learners create and navigate a web that is increasingly tailored to their own needs and interests". In compulsory schooling this trend is probably more related to teachers. But it is clearly challenging the way teachers, learners and publishers are working today. So far, this report has described how governments, publishers and groups of teachers and researchers are producing DLRs at the moment. But the changing landscape makes new scenarios for the production and use of DLRs possible. In such scenarios, new models of production, new business models and new ways of distributing and using DLRs should be taken into account. Below five embryonic scenarios on novel ways of producing, distributing and use DLRs are described.

The first builds on the Norwegian initiative NDLA which describes an interesting case of how teachers are more closely involved in production. A number of regional educational authorities has teamed up and decided to

produce some DLRs on their own instead of spending all their money on DLRs produced by publishers. They ask some of their teachers to do the authoring, with the same kind of salary as before. Since the teachers are producing DLRs on behalf of their employer, using the tools of the school, all the intellectual rights to the materials belong to the local educational authority. These materials are mixed with professionally produced ones bought by the authorities from publishers and media companies. All materials are published in digital format. The authorities have decided not only to share the materials among themselves but to publish all materials using Creative Commons licenses, which means that other teachers cannot only use the materials in their teaching but also adapt and reuse them. This is in many ways challenging the role of publishers in the educational market.

The second scenario is intended for local educational authorities. They could ask a teacher or a consultant to gather Open Educational Resources, *i.e.* materials already free for schools and materials they have the right to use in schools (usually because a Creative Commons license is used). The focus in this case is on gathering existing materials, not on their production. The work would be to compile materials to fit the local needs of the schools. Since the materials are open, local educational authorities could share these materials among each other, given that they also spend resources on tagging the DLRs with metadata making it possible to search for them and find them on the Internet.

The third embryonic scenario is directed towards publishers who need to respond to these challenges. One way of doing this could be to disaggregate content and offer smaller chunks of learning materials rather than fully fledged productions. Individual teachers, schools or local educational authorities could then subscribe to the repository and authoring tools and use these learning objects as they choose. On top of offering the content, publishers could provide the service of putting it together in a way that fits the local needs. This is similar to the OER model described above, but it would have an extra quality stamp both on the content and on the compilation process. The important thing is that again the "one size fits all" model is abandoned.

The fourth scenario is also intended for publishers. They could work in close cooperation with one or several local educational authorities and the local teachers, taking much the same role as NDLA in the Norwegian case. The role of the publisher would be to offer some of the content, to lead the compilation process putting its knowledge and quality stamp on the materials. The business model is that schools or local authorities would pay for the service as well as the content from the publisher.

The final scenario focuses on teachers. Teachers could very well work without both local educational authorities and publishers. The Internet opens up new opportunities for teacher associations or similar organisations to

play a role related to educational materials. One example could be a national association of teachers in mathematics or science starting an OER community and repository, inspiring and promoting teachers to develop and share resources among each other. The success of Lektion.se (SE4) is an example of the possible success of a teacher initiated and driven community. And, as described by the Horizon Report (2009), technological developments make it increasingly easy to find, sift and keep track of content.

It is hoped that the ideas presented in this chapter as well as the findings and analysis of this report will help to move forward the research agenda on the use and effects of DLRs and ICT on learning, given the growing importance of new technologies and digital media in modern societies.

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Appendix A

Cases Studied in the DLRs Project

Country	Name	Description	Designation
Denmark			
	EMU	The national educational portal for learning resources for schools, colleges and adult education un by the national agency UNI-C. The idea of the EMU is to have one central portal for information of relevance to the education sector. The EMU hosts a number of sub web sites. Most of the services are free of charge.	DK 1
	Subscription to DLRs	Publishers selling packages of DLRs and services to schools on a yearly basis. Schools subscribe to a package, which is regularly updated, and which is regularly expanded by new additions. Developers are given a better overview of their financial situation, and for schools the subscription means that they constantly receive new DLRs and that the resources are up-to-date.	DK 2
	ITIF (ICT in the public school)	Government programme with, among other things, resources for private companies to produce DLRs. It targeted primary and lower secondary education and ran from 2004-07. A central purpose of the ITIF project was to develop and make available web-based DLRs which could be used across subjects and classes. Eleven new DLRs have been produced by private publishing companies.	DK 3

Country	Name	Description	Designation
Finland			
	Virtual School including EDU.fi	The national educational portal. A part of the national Information Society Programme. The core of the Virtual School is a portal that is part of the online EDU.fi service maintained by the National Board of Education. The portal functions as a channel to disseminate best practices and offers information about study opportunities and learning materials. Responsibility for provision of virtual education lies with the schools and other educational institutions.	FI 1
	Peda.net	The Peda.net collection of web tools is a subscription-based service that emerged out of a small, regional R&D project at the Finnish Institute for Educational Research, University of Jyväskylä. This initiative currently provides both municipalities and individual schools throughout Finland with access to: a Virtual Learning Environment; a platform that allows teachers to create, collect, modify, and share information or materials; a WebMagazine authoring tool; and a tool for writing, maintaining and publishing the school curriculum.	FI 2
	Areena	The digital extension of YLE´s (Finnish National Broadcasting Service) televised production. Areena provides streamed (and soon downloadable) programmes that have been copyright cleared for online use.	FI 3
	Abitreenit	The Abitreenit exam preparation site, produced by YLE, allows pupils to revise for the paper-based matriculation exam using web-based materials, TV programmes and a discussion forum.	FI 4

Country	Name	Description	Designation
Iceland			
	The Educational Gateway	The national educational portal, run by the Ministry of Education, serves a number of functions, including indexing, highlighting, summarizing and (when possible) linking to on-line DLRs. It seeks to help teachers, learners and parents identify educational content available on the Internet, relevant to specific parts of the national curriculum, grouped by grade level and subject. It is also a clearinghouse for news, school-related information, information on education projects and initiatives, and hosts on-line discussions.	IC 1
	The National Centre for Educational Materials (NCEM)	National agency developing and translating educational materials which are sold to schools. NCEM provides compulsory schools in Iceland with educational materials, including DLRs, videos and CD-ROMs. It is state-run and financed by annual budget allocations although most materials are not for free. The materials are aligned with the national curriculum.	IC 2
	The School Web	Commercial company that provides DLRs aligned with the national curriculum. Access is for the most part restricted to subscribers. The site is one of the largest in Iceland, measured in content as well as in unique number of visitors. Ninety-eight per cent of compulsory schools in the country subscribe. A staff of around ten people made up of editors, content creators, production specialists and general office staff. Teachers and other content creators are contracted as needed.	IC 3
	The Language Studio	Support and materials for distance teaching of Nordic languages, supported by the city of Reykjavik. It targets students already competent in Norwegian, Swedish, English or Danish wishing to become more advance and competent in the languages they have already studied and in accordance with their age and maturity. It provides general advisory services for foreign language teachers in Iceland, especially teachers of Norwegian and Swedish.	IC 4
	The Katla Web	Support and materials for teaching Icelandic as a second language. Katla Web holds books and other materials, divided into 19 sections and printable from PDF files. Material is copyrighted and reserved for subscribers. The two developers worked at reception centres for foreign students in two primary schools in Reykjavík in 2000-07. Katla Web is currently run as a commercial company offering its services on a subscription basis.	IC 5
	IceKids	A web-based platform and a school and community for young expatriate Icelanders to keep up their mother tongue through courses, games and community in a safe online environment. The innovation was initiated at the Iceland University of Education. Other stakeholders were the Ministry of Education, Icelandic families living abroad and a number of sponsors, including the Ministry of Foreign Affairs.	IC 6

Country	Name	Description	Designation
Norway			
	Utdanning.no	The national educational portal with three components: a course description depository; a learning content metadata repository; and a learning content publishing framework. It provides links to DLR collections hosted elsewhere. It targets all user groups, including those in and outside the formal educational system and all educational levels and stages.	NO 1
	Aschehoug (with Lokus.no)	Publishing house with a web portal called Lokus.no. More than 33 titles in Norwegian have been made available through Lokus.no with all content tied to textbooks. Teachers and learners have anywhere, anytime access. Approximately 60% of all Norwegian upper secondary schools are registered users of Lokus.no.	NO 2
	You Decide	Government initiated campaign on the subject of data protection targeting primarily 15-16 year-olds. The key message is that young people should take a substantial degree of control over their own personal data, and secondly that it is important to respect other people's choices. The campaign initiated, among other things, a website with short videos.	NO 3
Sweden			
	IT for Teachers	The national educational portal, run by the National Agency for Education. The website is acting as a broker for a range of ICT resources and its target users are school teachers and leaders. It provides links to DLRs, courses in use of ICT, computer programs, suggestions for using ICT in school and reports of teacher experiences.	SE 1
	The Course Hub	Government-initiated DLRs repository for teachers. It started as part of the Swedish Agency for Flexible Learning, which is now liquidated. The Course Hub has been working to make lifelong learning possible for adults by enhancing and stimulating the development of flexible learning in municipal adult education, folk high schools, study associations, and at work places.	SE 2
	UR and the Media Bank	The Media Bank is a project developed by the Swedish Educational Broadcasting Company (UR). It is a web-based service providing free and open access to everyone of all radio and TV programmes broadcast in the last six months. In addition, schools, universities and adult education centres can access all programmes with no time limit in a closed network.	SE 3
	Lektion.se	A "bottom-up" community website where the users, mainly comprising teachers, upload, describe, metatag and share teaching and learning materials which they have produced. The materials are currently primarily PDFs. Initiated in 2001 it now has some 175 000 registered members. It is still driven by its three entrepreneurs, all of whom were originally teachers.	SE 4

Appendix B

ICT Strategies in the Nordic Countries

Denmark[1]

In 1998 the Danish Government launched a document called *Information and Communication technology in the education system*. This was an action plan for five years with special attention on five areas. The first was to strengthen the ICT skills of pupils'. Goals for pupils' ICT skills were set up with a special focus on their abilities to navigate the web. The second aim was to secure fast and cheap internet connections to schools. Thirdly, the document outlined a strategy, which moved the focus of governmental funding from internet connections towards development of web-based learning resources; some of them services run by the government. Fourthly, attention was given to examining the consequences of ICT integration for the various curriculum areas and emphasizing a changed role for teachers towards guides for pupils' independent work. Finally, priority should also be given to developing distance courses within open education and to make better use of research within the education systems.

In 2001 a new strategy called *Denmark's strategy for education, learning and IT* was published. Due to a change of government, it was never carried out but it pictures well the development within Denmark. The main objective in this strategy was a change in focus from learning *about* ICT to learning *with* ICT. It comprised six area of attention: Form and content of all subjects should be evaluated and revised in relation to ICT usage; ICT pedagogical education of teachers; Knowledge sharing within and between schools, and the development of tools for knowledge sharing; Using ICT for learning outside of school, for example in virtual learning courses; Improving the quality of education within the ICT industry, and; Using ICT for students with special needs.

In 2006 the Danish Government published its strategy *Denmark in the Global Economy*, which aims at Denmark having the World's best public

schools in a few years time. In order to achieve this, ICT must be integrated in all subjects, where relevant, as a tool to raise the subject level. Teacher education must also give more emphasis to ICT as a tool and a learning resource across the curriculum.

The latest Danish ICT strategy for schools was published in 2007. The *National Strategy for ICT Supported Learning* states that Denmark has the ICT infrastructural potential to use e-learning much more than today. The dominating focus of the strategy is to support a wider use of e-learning within educational institutions, the public sector and companies. E-learning is primarily understood as distance education. The strategy emphasizes utilization of e-learning advantages such as flexibility (in relation to time and space of education), and that individuals can learn at their own pace.

On top of these strategies, the Danish government have launched two major initiatives for ICT in primary and lower secondary schools: *IT Media and the Danish Folkeskole* (ITMF) which ran from 2001 – 2004 on a budget of EUR 45.7 million; and *IT in the Danish Folkeskole* (ITIF) from 2004-07 on a budget of EUR 66.5 million. ITMF adopted a bottom-up approach in terms of schools. The teachers were asked to define DLRs projects and to establish alliances with publishers and researchers. The objective of the programme was that these best practice results from the local projects should spread to all schools. Evaluations revealed that innovation occurred locally, but the countrywide dissemination of experiences and DLRs did not happen to the expected degree. The Ministry of Education took a top-down approach for ITIF.[2] The ITMF programme focused on the pupil as an active learner using ICT as a tool for his/her personal learning. Regarding DLRs, one aim was to digitize analogue TV broadcasts. Its successor, the ITIF programme, devoted the majority of its resources on purchasing computers for pupils in 3rd grade. This programme also had a strand on DLRs.

Finland[3]

The strategy *Education, Training and Research in the Information Society* from 1995, was an ambitious effort for establishing the guiding principles and building blocks for the Finnish information society. The main action lines were in: providing all citizens with basic information society skills both within and outside the formal educational system; focusing on teachers' professional skills in being able to support the ideas of lifelong learning and learner autonomy; developing information products and services; improving the opportunities for research in the information society; and building education and research networks. The plan was to have eight students per computer and all Finnish schools connected to the Internet by year 2000. The Finnish Ministry of Education spent over EUR 4 million in

1996 only on the development of teacher education and new learning environments. Efforts were also taken regarding in-service training. The target was that every fifth teacher should participate in training courses before 1999 – a goal never met according to evaluations. The evaluators also reported that the impact of technology investments had not been as strong as planned and the maintenance costs had taken up most of the resources allocated for integration of the hardware into the teaching practices. Moreover an acute shortage of DLRs was noticed.

These challenges were taken onboard in the following information strategy *Education, training and research in the information society. A national strategy for 2000-2004* where it was stated that ICT and course development must go hand in hand. Cross-disciplinary research projects were encouraged and supported, and evaluation of all processes was put at the core of all development. The financial investment is estimated at EUR 50 million. The goals were to ensure equal opportunities to extensively utilise the information resources and educational services. The required skills for all are seen to be media literacy and technology skills. This should be realised by creating virtual universities and polytechnics, through turning libraries and other public access points into mediatheques, and finally through guaranteeing an e-mail address to each citizen by year 2004. A teacher training framework was launched with a budget of EUR 5 million a year.

The *Information society programme 2004-2006* has three strands: knowledge, digital contents and operating environment. In terms of competencies, the programme recommends the extensive use of ICT in teaching and learning at all educational levels. The teacher training should be improved with the target of that at least 75% of the teachers should have the necessary ICT skills by year 2007. One important aspect in the strategy from the school point of view was the goal of 5-15 students per multimedia workstation in all schools. This goal was part of the objective of improving the learning environment in schools by ensuring better access to high-end computers.

Currently the *National knowledge society strategy 2007-2015* is being implemented. Among other central goals in the strategy is to ensure sustainable support structures for lifelong learning.

Iceland[4]

In Iceland a key policy document, called *The power of information: Proposals from the Ministry of education, science and culture about education, culture and information technology 1996-1999*, was released in 1996. It proposed more policy in the area and a clearer role for the Ministry. Thirty aims for the next three years were listed in three areas – the educational system, cultural life and the services to be provided by the Ministry. Each

of these three areas then received detailed attention with regard to imminent or possible change and objectives being set. In this seminal policy document the potential of DLRs and new opportunities for learning are suggested, even explored, more so than in any other policy document that was to follow. A number of "nuclear schools" were to be created to work closely with the Ministry and the teacher education institutions to, among other things, give advice on the design of educational software and experiment on using this software. Parallel to this, the Ministry launched a revision of the national curriculum which went on for three years 1996-99. They also provided grants to local ICT development projects and to in-service training of teachers. During this period there was also a major investment in infrastructure by the Ministry and by local authorities.

In 1999 a revised national curriculum was launched in all school subjects. The curriculum for ICT was found in the *National curriculum for information and technology education*. It stated clearly that ICT should be regarded as a cross-curricular tool, not a subject in itself. A revised version was published in 2007, but the revisions concerning ICT were minor.

A policy called *Advantage for the future; project plan for the Ministry of Education, Science and Culture for e-learning 2001-2003* appeared in 2001. The policy emphasized the concept of "distributed education" and using the Internet to increase educational opportunities for individuals that will materialise in different forms according to the school level and locality. One of the major projects undertaken by the Ministry was the establishment of an upper secondary school built on the concept of distributed education. Further in the policy it was noted that there was still a need to develop Icelandic materials, especially learning materials, on the Internet and to secure access to these materials. The Nordic cooperation underway at that time is said to have had a considerable effect on the direction taken in the policy.

The next policy document on ICT was called *Risk with responsibility: Policy for ICT in education, science and culture 2005-2008*. It was published in September 2005. The development division was again responsible for the review of policy. In this policy there was a return to some of the earlier themes from 1996, with policy guidelines being extended to culture as in 1996 and science. Five vision statements are introduced: access to the information society, ICT infrastructure, digital content, new opportunities and innovative practice and ethics and safety. For each vision there is a brief assessment of current status, objectives and actions to be taken.

Norway[5]

The Norwegian development during the last decade can be divided into three main phases. The first phase, *IT in Norwegian education 1996-1999*, was mainly concerned with the implementation of computers into Norwegian schools. There was less interest in the educational context. In the next phase, from 2000-03, the focus was more on whole school development with ICT and changing learning environments. During this period, approximately 33 000 teachers took part in in-service training related to ICT. The current phase places more emphasis on digital literacy to be acquired among students, and what learners do with technology, which opens future perspectives on technology and education. These initiatives are formulated in a national strategy called *Programme for digital literacy 2004–2008*. In 2006, an educational and curriculum reform for primary and secondary education called *Knowledge promotion* was launched. The goal of the reform is to help all pupils to develop fundamental skills that will enable them to participate actively in our knowledge society. Under Knowledge Promotion, schools are to prioritize the cultivation of basic skills in all subjects as an important foundation for all other learning. One of these basic skills is defined as "the ability to use digital tools". This has placed a strong emphasis on ICT as part of learning activities in schools. The way in which the use of ICT is implemented for the promotion of learning differs between the syllabuses. The major change from former plans on ICT in education is the demand for specific educational use of ICT in different subjects.

The overall vision in the *Programme for digital literacy 2004-2008* is to ensure digital competence for all. To achieve this, four focus areas are mentioned. The first is infrastructure, *i.e.* broadband access and support services for schools, which is seen as a precondition for digital competence. Although the main responsibility for ICT infrastructure in schools lies with the municipalities, the government has established a national agency to support these developments. The second is development of competence, which in this case means initial and in-service training for teachers. A national programme for in-service training of teachers, both related to technical skills and the educational use of ICT, has been developed. The third is DLRs, curricula and learning practices. The programme defines a great need to develop more and better digital learning resources within all subjects in order to stimulate teachers and students to use ICT more actively in their learning activities. Such resources are said to be closely linked to curriculum content and working methods in schools. One challenge is to better coordinate and make available what already exist. A national portal has been developed for this purpose, and also to make it possible for schools to share what they make of digital content themselves. The fourth focus area is research and development in the area of ICT and learning.

Sweden[6]

An important policy document for ICT in schools is called *Information technology – wings to human ability* (1994). The document predicts that ICT will change society dramatically. All children must learn to use ICT, since it will improve their learning processes. ICT will also lead to development of new pedagogical methods. Creativity will be released for both teachers and pupils to the benefit of both personal development and opportunities in working life. The policy stated, among other things, that all municipalities should have a strategy for use of ICT in schools but no funding was offered. The National Agency for Education was commissioned to initiate a national information network for schools.

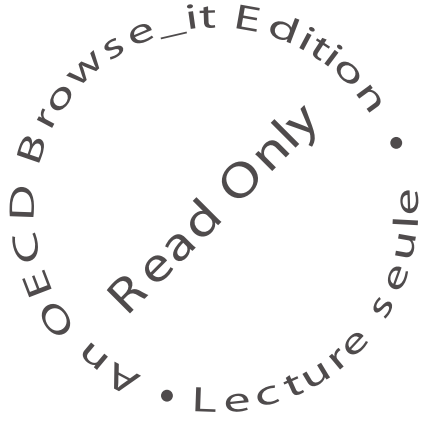
In 1995 the Knowledge Foundation launched a seven year programme for ICT in schools which included 27 *Lighthouse projects* and some smaller school projects; financial support to about 90 DLR projects, and dissemination of results through a school oriented webpage. Together with some support to the upcoming government programme, the Knowledge Foundation invested some EUR 114 million.

In 1998 the government released a policy, called *Tools for learning – a national programme for ICT in schools*. It stated that since society is changing due to the technological development, school and teaching must change as well. Student centred education and problem based learning was emphasised together with the ability to learn how to learn, and to prepare the pupils for lifelong learning. It was also stressed that ICT can bring new pedagogical methods as well as more international perspectives to schools. The programme following the bill, *ICT in schools 1999-2002*, comprised EUR 168 million. It focused on in-service training for teachers and infrastructure development for schools. About 60% of teachers participated in the in-service training which focused on teamwork and problem-based learning and carried out ICT development projects together with their pupils. All participating teachers were given a computer.

The policy document *From ICT policy for the society to policy for the ICT society* (2005) resulted in several working parties, one concerning education with representatives from key stakeholders in the education sector. The party suggested that a clear vision for ICT in schools should be developed. It was also suggested that goals and knowledge levels in digital competence should be defined in the curriculum and to update initial and in-service teacher training according to the needs of the information society. Some of the suggestions are in place. There is a national model on in-service training for teachers and the Knowledge Foundation is running a EUR 10 million programme to support the use of ICT in initial teacher training.

Notes

1. This section draws entirely on Dalsgaard, C. (2008), *Digital Learning Resources as Systemic Innovation – Country Background Report Denmark*.
2. Communication from Leo Højsholt-Poulsen, Uni-C.
3. This section draws entirely on Taalas, P. and Kankaanranta, M. (2008), *Digital Learning Resources as Systemic Innovation – Country Background Report Finland*.
4. This section draws entirely on Macdonald, A. (2008), *Digital Learning Resources as Systemic Innovation – Country Background Report Iceland*.
5. This section draws entirely on Erstad, O., K. Silseth and D. Dalaaker (2008), *Digital Learning Resources as Systemic Innovation – Country Background Report Norway.*
6. Hult, Å. and A. Westerdahl (2008), *Digital Learning Resources as Systemic Innovation – Country Background Report Sweden*.



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DIGITAL LEARNING RESOURCES AS SYSTEMIC INNOVATION IN THE NORDIC COUNTRIES

Technology is a key driver of educational innovation, and a variety of programmes focusing on investment in infrastructure, equipment, in-service training and digital learning resources have been established to promote its usage in primary and secondary schools. So far, little comparative analytical attention has been devoted to understanding how digital resources improve the quality of learning and to assessing the public policies that support their development and use, and the role played by other stakeholders like publishers, broadcasting companies and increasingly user communities. This publication aims to fill that gap by both reviewing and evaluating the process of systemic innovation. Drawing on case studies from five Nordic countries, the report assembles information on the knowledge bases and policy actors which impact each phase of this innovation process and the main factors which influence its success including governance, financing and user involvement.

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