CERC Studies in Comparative Education 23

PEDAGOGY AND ICT USE IN SCHOOLS AROUND THE WORLD

FINDINGS FROM THE IEA SITES 2006 STUDY




Edited by
Nancy Law,
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List of survey questionnaires

List of online tables of results

List of online figures of results

Abbreviations

BECTA	British Educational Communications and Technology Agency
CAB	Alberta Province, Canada
CAD	computer-aided design
CFA	confirmatory factor analysis
CHL	Chile
COP	community of practice
COT	Ontario Province, Canada
DNK	Denmark
DPC	IEA Data Processing and Research Center
ECT	Catalonia, Spain
EMB	Education and Manpower Bureau of Hong Kong
ERT	European Roundtable of Industrialists
EST	Estonia
EU	European Union
FIN	Finland
FRA	France
GDP	gross domestic product
GIS	geographic information system
HKG	Hong Kong SAR
HLM	Hierarchical Linear and Nonlinear Modelling
ICC	international coordinating committee
ICT	information and communication technology
ICT-EXP	Mean length of experience that schools in a system had with using ICT for pedagogical practices
ICT-TP-LLL	score for ICT-using teacher practices oriented towards promoting lifelong learning
IEA	International Association for the Evaluation of Educational Achievement
ISCED	International Standard Classification of Education
ISR	Israel
IT	information technology

ITA	Italy
JPN	Japan
LEADERSHIP	Principal's priority for leadership development
LLL	lifelong learning
LMS	learning management system
LTU	Lithuania
MPITE	Masterplan for IT in Education (Singapore)
NCES	National Center for Educational Statistics
NCQ	national coordinator questionnaire
NOR	Norway
NRC	national research coordinator
ODC	online data collection
OECD	Organisation for Economic Co-operation and Development
PC	personal computer
PD	professional development
PDA	personal digital assistant
PEDASUP	level of pedagogical support
PISA	Programme for International Student Assessment
PSTD	Programma di sviluppo delle tecnologie didattiche
RUM	Moscow, Russian Federation
RUS	Russian Federation
SAR	Special Administrative Region

Acknowledgements

From the Executive Director of the IEA, Dr Hans Wagemaker

The International Association for the Evaluation of Educational Achievement (IEA) has, for 50 years, conducted comparative research studies focusing on educational policies, practices and outcomes in more than 90 countries around the world. Organized around a secretariat located in Amsterdam, the Netherlands, and a data-processing center in Hamburg, Germany, the IEA, through its various projects, continues to study and report on widely varying topics and subject matters, including the use and impact of information technology in education. This volume reports the outcome of the IEA's most recent study in this area.

The IEA is particularly indebted to the directors of this project, Professor Nancy Law, Professor Tjeerd Plomp, and Dr Hans Pelgrum, for their leadership. We also strongly acknowledge the guidance provided by the members of the steering committee. Projects like SITES are not possible without a considerable amount of financial support. In this regard, I thank the Ford Foundation, the countries that contributed financially to this project and, in particular, the governments of Norway and Japan for their financial input. Also critical to the success of international projects such as SITES is the willingness of participating countries to commit to a set of common goals and procedures. Many teachers and principals gave willingly of their time, and for that I and my secretariat colleagues are continually thankful. Finally, I extend particular and sincere thanks to the national research coordinators, whose input has made this project a success and this volume possible.

From the Volume Editors and Authors

The international collaborative effort that is SITES 2006 was made possible through the contribution of many persons. We thank the NRCs of the 22 education systems that participated in this study (Appendix A gives names and contact details). They contributed substantially to its design, including questionnaire development. They also translated the instruments (where necessary) and collected the data from schools and teachers in their countries. We greatly appreciate the cooperation of the schools (roughly 9,000), their principals, and the technology coordinators and teachers (around 35,000). The international coordination of SITES 2006 was run by a consortium consisting of (1) an international coordination centre at the University of Twente (Tjeerd Plomp, study director, and W. J. Pelgrum, international coordinator), (2) the University of Hong Kong (Nancy Law and her team at the Centre for Information Technology in Education, University of Hong Kong), and (3) the IEA Data Processing and Research Center (DPC) in Hamburg.

We express our sincere thanks to Christian Monseur, University of Liège, the sampling coordinator for the study, and to our colleagues at the DPC for their expertise throughout SITES 2006. In particular, we acknowledge the DPC for designing an online data collection (ODC) system that proved very well tailored for this large-scale international comparative study. This system marked the first use of ODC in the history of international comparative assessments. We also greatly appreciate the many thoughtful suggestions received at various stages of the study from Ronald Anderson and Alfons ten Brummelhuis as members of the study's international steering committee. We are particularly grateful to the gracious hospitality of our hosts during NRC meetings held outside of the study consortium: Pornpun Waitayangkoon, Somsri Tangmongkollert (Phuket, Thailand), Renata Picco, and Roberto Melchiori (Frascati, Italy).

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Series Editor's Foreword

The International Association for the Evaluation of Academic Achievement, or IEA, conducts studies in countries across the world that are explicitly comparative, but although this might be the first reason to welcome this volume into the *CERC Studies in Comparative Education* Series, it is certainly not the last. This book reports and analyses the findings of the Second Information Technology in Education Study (SITES 2006), which was conducted under the auspices of the IEA. This is the first time that a book in this series has been solely dedicated to an IEA study, so why have we decided to publish this one in particular? Well, perhaps it's about time. One of the earliest volumes in the series – the sixth, in fact, published in 1999 – was Neville Postlethwaite's *International Studies of Educational Achievement: Methodological Issues*. Seventeen volumes and nine years later, we're publishing one such study. Postlethwaite's introduction to international survey studies and engagement with methodological issues that included sampling, instrument construction, and data collection, management and analysis, contributed critical insights to this highly significant and substantial field of comparative education research, and is today viewed as one of the key methodological texts in the field. This study, reported by Nancy Law, Willem Pelgrum and Tjeerd Plomp, represents the best of what Postlethwaite set down. The editors of this book are widely recognized as among the leading scholars globally in the field of information and communications technology (ICT) in education. And Nancy Law's *Centre for Information Technology in Education* (CITE) is recognized as a leading academic centre in the field.

One of the consequences of the increasing rate of globalization has been a reconsideration of national goals of education, which in some cases has contributed to national declarations of educational purposes that indicate an apparent need for education to go beyond the teaching of knowledge and skills to preparing younger generations to contribute to innovation and problem solving as members of a team. Such changes in educational goals have also brought about changes in methods of organizing and conducting teaching and of enhancing learning, as well as changes in roles played by teachers and learners. This book reports on a comparative study of ICT in education in the context of such global changes in policies and practices in education. Hence it is as much a book on pedagogy and changes in educational goals and practices as it is a book on ICT. The findings reported in this book will be valuable for education policy makers, practitioners, researchers and anyone else interested in understanding the changes in pedagogical practices in classrooms around the world, and the roles played by ICT in those changes. The book also sheds light on how policies and strategies at the school and system levels might influence whether and how ICT is to be used in classrooms.

In the Series Editor's Foreword to the previous volume published in this series, a month prior to the publication of this volume, I mentioned that CERC has recently been described, by the Co-Editor of the *Comparative Education Review*, David Post, as "one of the world's most important publishers of research in the field of comparative education". This volume, in its application of comparative education's research methods to the field of information and communications technology in education, is yet another reason why.

Mark Mason

Editor
CERC Studies in Comparative Education Series

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Foreword

How is information and communication technology (ICT) changing teaching and learning practices in secondary schools worldwide in the 21st-century? This is the central question addressed by researchers involved in the series of surveys comprising the Second Information Technology in Education Study (SITES). The question is a multifaceted one, with each facet raising additional questions relating to both theory and practice. These include the following:

- What traditional and new pedagogies are evident in the 21st century?
- What is the role of ICT in the teaching and learning process?
- What ICT-infrastructure is available in schools?
- How can teachers and their administrators be prepared for effective practice?
- How have these conditions and considerations changed since the first SITES survey in 1998?
- What are the trends within and between national education systems?
- What do the differences and similarities between these systems suggest?
- How should change be promoted in education in order to support teachers in their work?
- Is there evidence that key strategic factors commonly found in ICT-related educational policies do influence teachers' pedagogical use of ICT?

Because these questions are interconnected, the SITES 2006 researchers recognized that if we are to make sense of changes in pedagogical practices as a result of ICT-use, then we need to view those practices in terms of the interacting layers in the 22 education systems surveyed. The evidence presented in this report was therefore drawn from "layers" within each education system, most notably from principals and technology coordinators within the set of schools sampled for each system and from at least two mathematics and two science teachers teaching Grade 8 classes in each school. The evidence presented here also relates to a comparison across 15 of the 22 systems between the data gathered from the 2006 survey and that gathered from the 1998 survey (Pelgrum & Anderson, 1999).

The SITES researchers took extraordinary care with the thousands of questionnaires in many languages that came out of these surveys to ensure the data they contained could be compared across levels, systems, and time. The information that has emerged from the surveys confirms the complexity of change relative to ICT in education and the need for ecological perspectives on the socio-cultural changes occurring in education worldwide. The diversity of factors that influence a teacher's adoption of ICT can also be envisioned in layers that frame perspectives of the classroom as nested within the school, the local area, the region, and the global "biosphere" of education. For example, current theoretical models describe multi-staged adoption of ICT in a classroom that stems from each teacher's current concerns, with these, in turn, inter-connected with the vision of the leader of the department and the school (Davis, 2008).

The chapters of this book have been carefully organized to take readers through three layers of educational ecologies and their interactions, and also to educate readers on the many methodological challenges that beset the SITES researchers and the ways in which they solved them. Technology also played its part in the research process, with the participating systems able to engage in online data collection if they so chose, and with researchers having access to analytical tools including relational analysis with multi-level modeling. Building on the SITES 2003 case studies of innovative practice (Kozma et al., 2003), the researchers involved in SITES 2006 categorized pedagogical practices into traditional and two complementary aspects of 21st-century pedagogy, namely lifelong-learning and connectedness.

The findings presented in this book are fascinating and valuable. If the relevant agents within each system act on the implications arising out of these findings, we should see a considerably more effective use of the very large investments made worldwide in ICT in education. It is relevant to note here that publication of this important book coincides with UNESCO's release of its ICT-competency standards for teachers (UNESCO, 2008), which in itself is a confirmation that governments, experts, and practitioners increasingly are recognizing the important role that ICT can play in supporting educational improvement and reform.

The book's recommendations not only combine well but also verify an ecological perspective that could have better informed past initiatives. For example, adoption of SITES 2006 recommendation 5, "Policies that adopt a balanced, holistic approach catering for leadership development, professional development, pedagogical and technical support for ICT-use as well as improved ICT-infrastructure in schools will be more successful than policies focusing on one or two strategic areas,"could have avoided the widely publicized challenges of inadequate leadership development and infrastructure experienced in mandatory ICT-related teacher training in the UK (Davis, Preston & Sahin, 2008). In addition, the positive effect of recommendation 5 would be amplified many times if combined with recommendation 7, which links school development into the broader curriculum framework of the system or nation, and even more so if it were to include the 21st-century student outcomes emphasized in recommendation 1.

If our society is to adjust to and avoid damaging turmoil, alienation, and the threat of disintegration, then the impact and potential of ICT must be at everyone's fingertips. In short, we all have a role in its development (Dutton, 2004). It may be impossible to change our 19th- and 20th-century education systems to serve new generations equitably, but we must strive to do so. Lifelong learning and connectedness are essential additions to education designed for the 21st century, but they will not take firm root unless they are aligned with development of appropriate ICT-related pedagogies across and within our interlinked educational ecosystems, and herein lies the importance of this report on the SITES 2006 survey. This book provides the world with an extraordinarily valuable comparative study, and I recommend it to leaders of all education systems.

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Chapter One

Introduction to SITES 2006

Willem PELGRUM and Nancy LAW

The end of the last millennium was marked by rapid technological advancement and profound changes in many aspects of human activities, often referred to as indicative of the world moving into the knowledge age. Such changes have stimulated much discussion about the role and processes of education as well as the role of information and communication technology (ICT) in teaching and learning in the new era. Many policy documents on these themes have been published by international and regional organizations (e.g., the European Commission, 1995; the European Roundtable of Industrialists [ECT], 1997; the Organisation for Economic Co-operation and Development [OECD], 1999; UNESCO, 2003; the World Bank, 1998) and numerous master-plans on education reform and ICT in education launched by various governments since the mid-1990s. (e.g., Education Network Australia, 2000; the Education and Manpower Bureau of Hong Kong [EMB], 1998, 2004; the Educational Testing Service, 2002; the Finnish Ministry of Education, 1999; the Singapore Ministry of Education, 1997, 2002). Many of these policy initiatives brought with them a variety of strategic implementation priorities that differ from country to country depending on the specific socioeconomic and political contexts involved. Such educational strategies may involve, amongst others, changes in curricular and/or assessment practices at the system level, provision for ICT-infrastructure, teacher professional development, and technical and pedagogical support for teachers.

Given the profound technological, economic, and policy changes that took place over the last decade, are there indications that

N. Law et al. (eds.), Pedagogy and ICT Use in Schools around the World, 1–11.

pedagogical practices also changed during this period? What impacts, if any, are the pedagogical uses of ICT making in schools around the world? Is there any indication that the education policies and specific strategic implementations have made an impact on pedagogy and on ICT-use in classrooms? These are the questions that this book addresses through an analysis of the findings from SITES 2006, an international comparative study of pedagogy and ICT-use conducted under the auspices of the International Association for the Evaluation of Educational Achievement (IEA).

IEA decided in the late 1990s to conduct the Second Information Technology in Education Study (SITES), which is an international comparative research program exploring the use of ICT in education. SITES consists of several projects or modules. Its central theme is to foster our understanding of how ICT affects the learning and teaching taking place in schools. The study began in 1997 with a survey of the availability of ICT and its integration and use in schools. This study came to be known as SITES Module 1 (abbreviated as SITES-M1). This was followed by SITES Module 2 (abbreviated as SITES-M2), which was a comparative study of case studies of innovative pedagogical practices supported by ICT. SITES 2006—the study reported in this book—is the third module in this program, and its aim is to provide a comprehensive understanding of how teachers teach, both generally and in situations when ICT is used, as well as how school- and system-level factors affect teachers' pedagogical adoption of ICT.

This chapter summarizes the previous SITES modules and provides a short overview of SITES 2006 and the education systems that participated in the study. It also provides an outline of the rest of this book.

1.1 Previous SITES modules

1.1.1 SITES Module 1

The *Second Information Technology in Education Study Module 1* (SITES-M1) was an international comparative study designed to help countries estimate their current positions, relative to other countries, in terms of their use of ICT in education. The study established baselines against which developments could be judged in subsequent years. Moreover, the comparative data were intended to assist national policymakers reflect on improvements that might be considered for the near future.

The study was designed as a survey of principals and technology coordinators from a representative sample of schools in each of the participating countries (or education systems). A total of 26 systems from *Europe* (Belgium-French, Bulgaria, Cyprus, the Czech Republic, Denmark, Finland, France, Hungary, Iceland, Italy, Latvia, Lithuania, Luxembourg, Norway, the Russian Federation, the Slovak Republic, Slovenia), *Africa* (South Africa), the *Middle East* (Israel), *North America* (Canada), and *Asia* (Hong Kong SAR, Chinese Taipei, Japan, New Zealand, Singapore, Thailand) participated. Schools were sampled at one or more of three levels in the education system: primary, lower secondary, and upper secondary. The data collection for the study took place between November 1998 and February 1999. Dr Willem J. Pelgrum directed the study from its international coordination center located at the University of Twente in the Netherlands. The results of the study are presented in Pelgrum and Anderson (1999) and are briefly summarized here.

The study addressed four questions:

1. To what extent does the school management offer a supportive climate for the use of ICT in the school?
2. What ICT-infrastructure (equipment, software, access to internet, and the like) is available in schools?
3. What staff development and support services exist with regard to ICT?
4. To what extent have schools adopted objectives and practices that are considered important cornerstones of education in the global information society?

In general, the study found that school principals tended to have a positive attitude toward ICT-use in their schools. On a variety of questions related to principals' attitudes to aspects such as the impact of ICT on achievement, the relevance of internet, the impact of ICT on school management, and the contribution of ICT to lifelong learning, principals from all participating countries responded positively. However, countries differed in the extent of their positive responses. For example, lower secondary principals in Singapore had a relatively high score on an indicator of the contribution of ICT to learning, but in Hungary and Japan the average scores were much lower. A majority of school principals also reported having adopted ICT-policies of various types in their school, such as plans for equipment replacement, staff development, software acquisition, and equity of access and internet use. Despite these gains, in many countries a substantial group of principals admitted they had yet to realize these goals.

With regard to the ICT-infrastructure in schools, the study examined the student–computer ratio across countries. This ratio indicates how many students per computer there are in a school. A ratio of 20 to 1, for instance, means that if all students want to use the equipment at the same time, 20 students would have to share each available computer. The student–computer ratios for lower secondary schools ranged from approximately 9 to 1 in Canada and 12 to 1 in Denmark and Singapore to 133 to 1 in Lithuania and 210 to 1 in Cyprus. While 13 of the 24 systems that responded at the lower secondary level had a ratio of 30 or fewer students per computer, the other 11 countries had higher—sometimes much higher—ratios.

This ratio has come down significantly over the past several years, however. Comparison of the SITES-M1 data with similar data collected in 1995 as part of IEA's Third International Mathematics and Science Study or TIMSS (see Beaton, Mullis, Martin, Gonzalez, Kelly, & Smith, 1996) showed substantial declines in this ratio for every country that participated in both studies. Norway, for example, dropped from a ratio of approximately 55 students per computer to 9 students per computer in the SITES-M1 study, while Thailand dropped from 206 to 62.

SITES-M1 also examined the extent to which schools had access to the internet for instructional purposes. Again, there were significant differences between countries. In 1998/1999, 100% of the participating lower secondary schools in Singapore and Iceland had access, while this figure was 98% in Canada and 96% in Finland. At the other end of the scale, only 11% of Cypriot lower secondary schools and 4% of Russian lower secondary schools had access to internet in 1998/1999.

Despite a general increase in the availability of computers and their connection to internet, the problem most often mentioned by respondents was an insufficient number of computers. Other infrastructure-related problems often mentioned by respondents included a lack of peripherals, not enough copies of software, and insufficient numbers of computers that could simultaneously access the internet.

However, the second most-often mentioned problem was teachers' inadequate knowledge and skills regarding ICT. While the majority of schools reported having a policy goal of training *all* teachers in the use of

ICT, in most countries this goal had been achieved in only a minority of schools. Across countries, a majority of the technology coordinators said they were adequately prepared with regard to *general* applications (such as word-processing, databases, and spreadsheets). A much lower percentage indicated that they were adequately prepared in the *pedagogical* aspects of ICT (for instance, didactical integration and applications of subject-specific software).

Perhaps the most significant goal of SITES-M1 was to examine the extent to which countries were changing their approach to pedagogy and to look at the contribution that ICT was making to this change. Principals were asked a number of questions about the presence of various pedagogical practices in their schools. This list of questions is presented in Box 1.1. A factor analysis was run on the responses to these questions, and two factors were identified: one called *emerging practices* and the other called *traditionally important practices*. The emerging practices factor was formed from items 1, 2, 3, 4, 8, 9, 10, and 13 in Box 1.1, while the traditional practices factor was formed from items 5, 6, and 7.

Box 1.1 Types of pedagogical practices examined in SITES-M1

Question:

To what extent is each of the following aspects of teaching and learning present in your school? (Response alternatives were not at all, to some extent, a lot, for each of the following practices.)

1. Students developing abilities to undertake independent learning
2. Providing weaker students with additional instruction
3. Organizing teaching and learning so that differences in entrance level, learning pace, and learning route are taken into account
4. Students learning to search for information, process data, and present information
5. The emphasis in learning is on the development of skills
6. Students working on the same learning materials at the same pace and/or sequence
7. Teachers keeping track of all student activities and progress
8. Students being largely responsible for controlling their own learning progress
9. Students learning and/or working during lessons at their own pace
10. Students involved in cooperative and/or project-based learning
11. Students determining for themselves when to take a test
12. Students learning by doing
13. Combining parts of school subjects with one another (multidisciplinary approach)

In brief, the emerging practices included those that described students as being actively engaged in, and responsible for, their own learning, that involved students in cooperative or project-based learning, that engaged students in searching for information, and that allowed students to work at their own pace and to determine when to take a test. Traditional practices were those that emphasized the development of skills, with all students working on the same materials at the same pace, and teachers keeping track of all student activities and progress.

Many of the participating schools around the world indicated that the emerging pedagogical practices were present to a large extent in their schools. However, as with other indicators, there were also large differences between countries in terms of their pedagogical practices. For example, students from lower secondary schools in Denmark, Hungary, and Norway scored at a relatively high level on the indicator of emerging pedagogical practices. Students from Hong Kong and Japan scored lowest. In relation to traditional practices, scores in Luxembourg and Thailand were high and in Norway were low.

Beyond this, principals were asked to report on the extent to which ICT had contributed to realization of the various emerging pedagogical practices in their schools. In Canada, Denmark, Hungary, Israel, and Slovenia, a majority of lower secondary principals responded affirmatively, but only a minority of school principals in the French Belgium community, Hong Kong, and Japan did so.

In summary, SITES-M1 established that many school principals considered ICT to be important in their schools and that many schools had developed local policies regarding its use. There had been a significant investment in computers in schools. In many countries, the student–computer ratio was below 30, and this figure had fallen significantly since 1995. A large investment had also been made in order to connect schools to the internet. These results correspond to findings from other similar studies (Anderson & Ronnkvist, 1999; European Commission, 2001; National Center for Educational Statistics [NCES], 2001). SITES-M1 data indicated that this investment had started to pay off in many countries, at least in some schools, as teachers had begun to use ICT to change their pedagogical approach to a more student-centered one.

The relationship between ICT-use and innovative pedagogical practices in classrooms was explored in further depth in SITES-M2, as is described in the next section.

1.1.2 SITES-M2

SITES-M2 focused on the extent to which classrooms around the world judged to be innovative were engaging in constructivist, knowledge-building practices that integrated ICT into the curriculum and assessment. The study adopted a comparative case study method to address research questions that aimed to shed light on the nature of the emerging pedagogical paradigm established in SITES-M1 and how this related to the broader set of contextual factors at the classroom, school, and system levels. In each of the 28 systems that participated in the study, which are listed in Appendix A, national panels used a set of common selection criteria to identify a number of innovative classrooms. This approach resulted in 174 case studies of innovative pedagogical practices using ICT.

National research teams then used case study methods to collect data on the pedagogical practices of teachers and learners, the role that ICT played in these practices, and the contextual factors that supported and influenced them. The international coordinating committee (ICC) conducted a cross-case analysis using qualitative and quantitative methods. Implications were drawn for both improved policy and classroom practice (Kozma, 2003; www.sitesm2.org). The results of this study provided teachers all over the world with outstanding examples of how technology can change classroom teaching and provided policymakers with guidelines on how to increase the positive impact of technology on their education systems.

Key findings from this study included the following:

- In a substantial number of cases, technology was supporting significant changes in classroom teaching and learning. These cases painted a very different picture from that of the traditional classroom where the teacher lectures in front of the classroom and students take notes or do worksheets. The changes also showed important similarities in the manner in which many countries around the world were using technology.
- In these selected cases, students were actively engaged in what are sometimes called “constructivist activities,” such as searching for information, designing products, and publishing or presenting the results of their work. Students were often collaborating with one another on these projects and occasionally collaborating with others outside the classroom, such as students in other countries. Productivity tools, such as word-processors and presentation

software, were being used in a majority of the cases, as were internet resources, email, and multimedia software. These tools and resources were being used to create products and presentations, to support communication, and to search for information.

- A large majority of the case reports found that teachers were creating structure for students by organizing student activities. Teachers were also advising students and monitoring or assessing student performance while the students were engaged in the innovation. A majority of the cases reported that teachers were collaborating with other teachers as part of their innovation. And in a few of the cases, teachers reported collaborating with people outside the class, such as professors, scientists, and businesspeople.
- Certain patterns of practices were more likely to be associated with significant positive outcomes. For example, in cases where technology supported students to collaborate with one another, to conduct research, and to analyze data, the respondents were far more likely than respondents with other practice patterns to report that students had acquired new ICT, problem-solving, and collaboration skills.
- A large number of cases were in the sciences. Languages—both mother-tongue and foreign—accounted for another large group. A smaller group of cases were in the social sciences or creative arts. Many of these ICT-based innovations involved multidisciplinary projects. In only 29% of the cases was the innovation limited to a single subject area. A small minority of the cases involved only the study of computer literacy, computer science, or "informatics" as a subject area.
- These technology-supported innovations were having a limited impact on the curriculum. Only 18% of the 174 cases reported a change in curriculum goals or in the incidence of content that was supported by technology.
- While 75% of the innovations had been used for at least a year, only 41% provided evidence that the innovation had been disseminated to other classrooms or schools. In the schools where these innovations had been both continued and disseminated, continuation depended on the energy and commitment of teachers, student support, the perceived value of the innovation, the availability of teacher professional development opportunities, and administrator support.

- Innovations were more likely to continue if there was support from others in the school and from external sources, innovation champions, funding, and supportive policies and plans. Particularly important was the connection with national technology plans that provided resources that often enabled the innovation to succeed.
- Policies—both local and national—were important to the success of many of the 174 innovations.

1.2 SITES 2006 in brief

SITES 2006, designed as a survey of schools and teachers and building on the findings of SITES-M1 and SITES-M2, examined the kinds of ICT-related pedagogical practices adopted by the participating countries and how these countries were using ICT. The main aims were to find out:

1. The extent to which the characteristics of the innovative ICT-using pedagogical practices identified in SITES-M2 could be found within the general population of teachers as opposed to those teachers identified as being involved in highly innovative practices; and
2. How the presence of these characteristics related to contextual factors at the school and system levels.

The study administered three questionnaires (for school principals, technology coordinators, and teachers in mathematics and science) to a sample of approximately 400 schools and about four teachers per school in each participating education system. A noteworthy feature of SITES 2006 is that most data were collected via an online data collection (ODC) system specially developed for this study and containing many features that are needed in international comparative assessments.

The study began in October 2004, and the main data collection process took place in 2006. In 2005, the participating countries adapted, translated, and piloted the instruments. The training of local project personnel also took place in that year. Researchers from the University of Twente, the University of Hong Kong, and the IEA Data Processing and Research Center coordinated the study.

1.3 Countries participating in SITES 2006

A total of 22 countries were involved in SITES 2006. These are listed in Table 1.2. Because participation in SITES 2006 was based on education systems rather than countries, the term "education systems" is generally used throughout the rest of this book.

Of the 22 education systems that were involved in SITES 2006, 15 were also involved in SITES-M1. For these systems, trend data on a number of indicators are shown in Chapter 4, which reports on the school level-data. These systems are marked in Table 1.1 with [M1].

Table 1.1 Education systems that participated in SITES 2006

Education systems (acronyms used in this book)	
Alberta Province, Canada (CAB)	Japan [M1] (JPN)
Catalonia, Spain (ECT)	Lithuania [M1] (LTU)
Chile (CHL)	Moscow, Russian Federation (RUM)
Chinese Taipei[M1] (TWN)	Norway [M1] (NOR)
Denmark [M1] (DNK)	Ontario Province, Canada(COT)
Estonia (EST)	Russian Federation [M1] (RUS)
Finland [M1] (FIN)	Singapore [M1] (SGP)
France [M1] (FRA)	Slovak Republic (SVK)
Hong Kong SAR [M1] (HKG)	Slovenia [M1] (SVN)
Israel [M1] (ISR)	South Africa [M1] (ZAF)
Italy [M1] (ITA)	Thailand [M1] (THA)

Note: [M1] means that this education system also participated in SITES-M1.

1.4 Outline of this book

Chapter 2 contains a description of the conceptual framework and the research questions addressed in this study. The study design and methodology are also summarized in Chapter 2. For technical details about the study, readers are referred to the technical report (Carstens & Pelgrum, 2008).

The next four chapters deal respectively with the findings of the study at macro-, meso-, and micro-levels and contain information about respectively the system-level context (Chapter 3), school-level indicators of conditions affecting the use of ICT and pedagogy (Chapter 4), and teacher-level indicators regarding pedagogical approaches, the use of ICT, and the way these are affected by teacher characteristics, including teachers' perception of pertinent school-level conditions (Chapters 5 and 6).

Chapter 7 contains information about a part of the teacher questionnaire that was included as an international option in SITES 2006. This component consisted of teachers' descriptions of the most satisfying experience they had each encountered when using ICT in their teaching and how they perceived the impact of that practice.

Chapter 8 focuses on exploring relationships between school- and teacher-level indicators to determine if some key strategic factors commonly found in ICT-related educational policies do, indeed, have an impact on teachers' pedagogical use of ICT. This chapter also contains a summary of the key findings from SITES 2006 and a discussion of the policy implications for teachers, school leaders, and policymakers.

Chapter Two

Study Design and Methodology

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A considerable body of recent literature describes the profound changes occurring as societies move from agricultural and industrial economies to a highly interconnected global knowledge economy (see, for example, Dertouzos, 1997; Tapscott & Williams, 2006). In the industrial age, the pace at which new knowledge evolved was relatively slow and a major role of schooling was to ensure that students mastered a well-defined set of knowledge and skills. However, with the advent of the 21st century, people are finding such abilities no longer sufficient when facing the everyday realities of the workplace. These realities demand making rapid decisions based on incomplete information when tackling novel situations, an aptitude for working through a plethora of information of varying levels of accuracy when tackling ill-defined problems, and the capacity to collaborate with a diverse team that may be distributed globally when endeavoring to accomplish personal and organizational goals (Peters, 1997).

Citizens in the 21st century must also be prepared for lifelong learning because learning is no longer confined to the young or to institutional contexts (Young, 1999). Hence, there are strong arguments that the educational outcomes core to wellbeing in the knowledge economy are different from those in the industrial age and should encompass higher-order cognitive, affective, and social skills (Drucker, 1988). Given such a context, it is not surprising that a number of high-profile regional, national, and supra-national projects have been

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conducted to develop descriptions and frameworks for 21st-century student success in the knowledge economy. Examples include the European Commission's proposal for a 21st century e-skills agenda (http://europa.eu/rapid/pressReleasesAction.do?reference=IP/07/1286&format=HTML&aged=1&language=EN&guiLanguage=en), the enGauge 21st Century Skills project (http://www.ncrel.org/engauge/skills/skill21.htm) of the North Central Regional Educational Laboratory, and the Partnership for 21st Century Skills project in the United States (http://www.21stcenturyskills.org/). These projects not only have identified the crucial characteristics desired of learners in the knowledge economy but also emphasized the importance of ICT-skills and information literacy in the context of 21st-century learning outcomes.

A strong theme running through these projects is that curricular and pedagogical changes need to take place if schools are to successfully help students develop these learning outcomes. The role of ICT is envisaged not simply as a technical skill or as a means of improving learning effectiveness but also as a way of transforming the goals and processes of education. In fact, there is increasing evidence that young people who have always been surrounded by and interacted continuously with ICT develop a different approach to learning and knowledge management from students who have not had this opportunity (Pedró, 2006). The OECD is conducting a study on these "new millennium learners" to examine the challenges they pose and the extent to which their emergence will contest prevailing views of interpersonal communications, knowledge management, and learning within schools.

It is within this context of change and desire for change in education that the three SITES projects have been designed and conducted. As Pelgrum and Anderson (1999, p. 3) explain, the SITES program is motivated by the desire to provide empirically based answers to the following questions:

1. To what extent have education systems adopted and implemented objectives that are considered important cornerstones of education in the Information Society?
2. To what extent is ICT facilitating implementation of objectives that schools intend to achieve?
3. What differences in ICT-related practices exist within and between systems and how can these differences be explained?

It is well documented in academic literature that use of ICT per se does not necessarily facilitate achievement of these desired learning outcomes (see, for example, Fisher, 2006; Pearson & Somekh, 2006; Watson, 2001). There is also strong research evidence that significant changes in the pedagogical process (a term that we use interchangeably with the teaching and learning process) are necessary to achieve these new curriculum goals (Law, in press; Somekh & Davis, 1997). Hence, in SITES-M1, indicators for pedagogical orientations were developed to answer the above questions.

SITES-M2 was a qualitative study that employed comparative case studies methodology. Conducted between 1999 and 2003, it provided rich data about highly innovative cases of ICT-use in classrooms considered indicative of future classrooms (and the pedagogical practices conducted in them) in countries around the world (Kozma, 2003). Analyses of the 174 case studies collected from 28 systems globally provided a rich empirical base for the development of further indicators of pedagogical orientation in the SITES 2006 study. As these indicators are core to the design of this study, a brief description of how they built on and evolved from the previous two SITES studies is provided in the next section, after which we present the details of the study design.

One very significant finding from the study was that despite the extremely wide economic and cultural differences existing among the 28 participating countries and education systems, the national selection committees established very similar selection criteria for innovativeness. Furthermore, the 174 case studies collected from primary and secondary schools around the world actually shared many common features in terms of their classroom practices. These included changes in the roles played by students and teachers and the use of technology to connect students and teachers to peers and experts outside school, even though the school curricula and levels of access to technology in the schools were very different.

At the school level, common patterns of contextual factors were also found in cases that demonstrated sustainability. SITES 2006 built on these earlier findings, and sought, through surveys of teachers, principals, and ICT coordinators, (1) to understand the extent of and the ways in which countries around the world accomplish ICT-integration in their classroom practices, and (2) to identify those factors that most contribute to the effective integration of ICT in learning and teaching.

2.1 Emerging pedagogies for lifelong learning and connectedness in the 21st century

In SITES Module 1, the concept of *emerging paradigm* was developed to capture those changes occurring in classrooms internationally that align with what is believed to be conducive to the development of learning outcomes important for the information society. Some of these changes include higher indices of learning, such as self-directed learning, and collaborative inquiry, for the student. They also require teachers to take on more of a facilitative role, not only in guiding students' independent learning and self-monitoring, but also in ensuring evaluation. It is conceivable that many of the teaching and learning activities that were well established in the industrial society, such as teacher-driven, lock-stepped homogeneous pacing, teacher-driven instructions, and students learning individually and being assessed via close-ended tests and examinations, still occupy an important place in classrooms. SITES Module 1 referred to these activities as belonging to the *traditionally important paradigm*.

Within this framework, traditionally important practices were not conceptualized as "bad" or "poor" practices because it is conceivable that they still contribute positively to students' learning. However, the interest was in finding out whether practices belonging to the emerging paradigm could be identified and, if yes, where the balance between these two kinds of activities lay. Based on this conceptual framework, indicators were constructed to identify principals' perceived presence and importance of traditionally important and emerging pedagogical practices in their schools. The SITES-M1 study found significant differences across countries in terms of the relative importance that principals in their own schools assigned these two kinds of practice.

By focusing on innovative pedagogical practices, the SITES-M2 case studies provided very rich descriptions of what might count as emerging characteristics of pedagogical practices that make substantial use of ICT. Kozma and McGhee (2003) reported evidence from the case studies that use of ICT often leads to changes in teachers' and students' roles and practices. They also identified two core models in these practices—the Student Collaboration Model, in which students collaborated with others in their classes to search for information, and the Product Model, in which both teachers and students created products that often involved using multimedia tools and web resources for research and problem-solving purposes. There was also evidence that some of these practices provided students with opportunities to take responsibility for their own learning, to identify their own learning needs and strategies, and to develop collaboration, inquiry, and communication skills. These aptitudes all align with the 21st-century educational outcomes described in the previous section.

Adopting another analysis framework, Law (2003, 2004) identified, in addition to the dimension of technology use, five dimensions along which significant changes were seen to have taken place in the SITES-M2 case studies. These were curriculum goals, the roles of the teacher, the roles of the learner, the multidimensional ways in which students' learning outcomes can be manifested, and connectedness with peers and experts outside the classroom walls. The connectedness dimension highlights a prominent feature found in the Outside Collaboration Model—one of the student models evident in Kozma and McGhee's (2003) analysis. In this model, students collaborated with outside peers and experts to create products and publish results. Law's (2004) analysis also found that the Asian case studies showed much less evidence of connectedness compared to those cases collected from other regions of the world, a finding that suggests connectedness is a more culturally dependent dimension than are the other five dimensions.

In designing the pedagogical orientation indicators for the SITES 2006 study, the research team considered it desirable to replace the indicator for the emerging paradigm with a more refined set of indicators. At the time SITES-M1 was designed, there was little certainty over the extent to which the activities considered within the emerging paradigm would be present within schools generally. Moreover, because SITES-M1 was a study of schools that involved surveying only principals and technical coordinators, the questions on the pedagogical paradigm were given to principals only; the research team considered that it would be inappropriate to ask principals questions involving details of classroom practices. However, because SITES 2006 focused on what happens in classrooms, data were collected through teacher questionnaires, making it possible—and, in fact, desirable—to probe into classroom practices in greater detail.

The rich descriptions and associated analyses of the innovative practices collected through SITES-M2 provided a good empirical basis for the development of more refined indicators of the emerging paradigm. Given that the *connectedness orientation* appeared to be a more culturally bound characteristic of the innovative practices, the research team decided that separate indicators should be developed to capture this aspect of the changing pedagogy in schools. Other descriptors of the innovative practices related to the use not only of more collaborative-, inquiry-, and production-oriented activities but also of strategies designed to take greater account of individual differences, such as the provision of remedial instructions. After completing several rounds of explorations, the research team developed another set of indicators, labeled the *lifelong learning orientation* and designed to capture these aspects of the innovative practices.

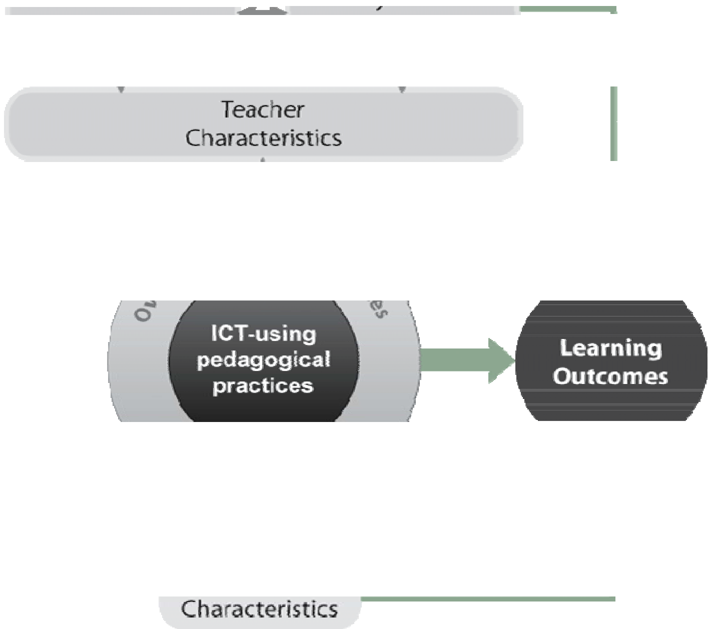
Lifelong learning is a term that often appears in the literature related to education in the 21st century. This term is often used to refer to post-compulsory education or to continuing education, offered to people who are in the workforce (Field, 2006). However, various commentators strongly argue that lifelong learning should be an important agenda for schools (see, for example, Young, 1999). The "curriculum of the future," according to Young, should prepare students not just to pass examinations but also to be lifelong learners in contexts where there may not be teachers. School curricula should "move from being heavily 'designed' in timetables, syllabuses, and lesson plans to relationships between learning at school and learning in non-school contexts" (Young, 1999, p. 474). This sense is the one ascribed to the term lifelong learning used in this study. Because both lifelong learning and connectedness are features of 21st-century learning outcomes, the term 21st-century pedagogical orientation is sometimes used in this book to refer generally to both lifelong-learning and connectedness orientations.

2.2 Conceptual framework and research questions

2.2.1 Conceptual framework

While SITES 2006 studied both classrooms and schools, the focus of the study has been on what happens in the classroom and how ICT is used in it. Consistent with the conceptual frameworks adopted in the previous two SITES studies (see Kozma 2003; Pelgrum & Anderson, 1999), SITES 2006 took the view that ICT-using pedagogical practices are part of the overall pedagogical practices of the teacher. For teachers, the reasons for and the ways of using ICT in the classroom are underpinned by their overall pedagogical vision and competence. Also, pedagogical practices are not determined solely by the characteristics of the teachers, such as their academic qualifications and ICT-competence, but also by school- and system-level factors. While we expect students' learning outcomes to be influenced by the pedagogical practices they experience, we need to acknowledge that the outcomes (whether perceived or actual) influence the subsequent pedagogical decisions of the teacher. This is because teacher-, school-, and system-level factors often have to change or be changed to accommodate the expected or actual impact of pedagogical practices on students. Figure 2.1 presents the overall conceptual framework for the study.

Figure 2.1 Overall conceptual framework for SITES 2006



2.2.2 Research questions

SITES 2006 set out to tackle four research questions:

- *Research Question 1: What are the pedagogical practices adopted in schools and how is ICT used in them?* This question aimed to identify the key pedagogical approaches and practices adopted by teachers in their teaching, to assess the importance assigned to using ICT when implementing these different approaches and practices, and to document the perceived impacts of ICT-use on students. This, the main research question to be answered through the teacher questionnaire, included carefully designed quantitative indicators.

- *Research Question 2: What ICT is used and how is it used in specific situations where ICT has been employed relatively extensively within a pedagogical practice?* This question endeavored to gather descriptions from teachers of the satisfying experiences they had encountered when using ICT in their teaching. Teachers who had used ICT extensively in their teaching of the target class were asked to identify one example of practice from their own past experience in which they or others had used ICT to support learning and teaching. They were also asked to report on the contributions they thought ICT had made to their teaching practice and to student outcomes. Hence, while some qualitative data were collected from the questionnaire, the information was used primarily quantitatively to provide a more holistic picture of how ICT was actually being used in specific contexts. Also, this part of the teacher questionnaire was an international option, which meant that the participating systems could decide whether to include it.
- *Research Question 3: What teacher, school, community, and system factors are associated with different pedagogical approaches and ICT-use, and can an explanatory model be identified?* SITES-M2 (Kozma, 2003) as well as other research studies (Becker & Ravitz, 2001; Fullan, 1993; Jones, 2004; Owston, 2003; Scrimshaw, 2004) identified certain contextual factors as important conditions for ICT-use and innovative pedagogy. Research Question 3 explored the status of such factors, how these might relate to different characteristics of pedagogical practices and ICT-use, and whether any systematic differences could be observed across countries in relation to the explanatory models identified.
- *Research Question 4: What system factors are associated with different pedagogical approaches and ICT use?* Four clusters or spheres of system-level factors were explored in the study: demographics, education system, pedagogical trends, and ICT-related policies. All of the data for these spheres came from the national coordinator questionnaire (NCQ), except for the demographics cluster, which included demographic and technology indicators from the *Human*

Development Report, 2006 (United Nations Development Program [UNDP], 2006).

2.3 Design of the survey instruments

Unlike SITES-M2, which compared in-depth case studies, SITES 2006 aimed to provide an overall picture of the status of pedagogical practice and ICT-use in the participating countries and systems. Therefore, survey methodology was considered appropriate. The main data collection was done using three questionnaires: a teacher questionnaire, a principal questionnaire, and a technical questionnaire. In addition, a national context questionnaire was distributed to the study's national research coordinators (NRCs) in order to gather relevant contextual information at the system level from each country or system in the study. The design of each instrument is described below.

2.3.1 Teacher questionnaire (core component)

The core component of the teacher questionnaire was designed to address Research Question 1 as well as contribute to answering Research Question 3 (above). As described earlier, the pedagogical approach of the teacher is an important concept in this study. The SITES-M2 findings indicated that the curriculum goals and the roles played by teachers and by students in the learning process were the three aspects most indicative of the pedagogical approach of the teacher. Hence, three sets of *core indicators* of pedagogical orientation were developed, namely the curriculum goal orientation, the teacher's role orientation, and the student's role orientation. These indicators were constructed on the basis of teachers' responses to questions on the relative importance of a range of curriculum goals and the relative frequency of occurrence of a range of teacher activities and student activities. Each set contains three indicators, reflecting the relative strengths of the traditionally important, lifelong learning, and connectedness orientations respectively. In addition, for each item on the list of teacher and student activities, teachers were asked to indicate whether or not ICT had been used in those activities. This latter set of responses was used to compute two further sets of *core indicators* of the pedagogical orientations relating to ICT-using teacher and student practices respectively.

To ensure that comprehensive answers could be obtained to

Research Question 1, and to provide indicators additional to the core ones, the SITES researchers produced further questions in the teacher questionnaire that were designed to provide indicators of the following: methods of organizing teaching and learning; the location of and time when teaching and learning occurred; the learning resources (including ICT) used; the assessment practices they used and whether these employed ICT; and the perceived impact of pedagogical ICT-use on students. These indicators were called *supplementary indicators*.

Data on a number of contextual factors that might influence teachers' pedagogical ICT use were also collected through the teacher questionnaire. This information included the teachers' self-reported ICT-competence, the obstacles teachers thought hindered use of ICT in their teaching, the availability of ICT-related professional development courses, the extent of teachers' participation in that development, and the presence of a community of practice in the school (Dexter & Anderson, 2002; Dexter, Seashore, & Anderson, 2002; Geijsel, Sleegers, van den Berg, & Kelchtermans, 2001). Teachers were also asked about the priority they had accorded ICT-use in their teaching during the next academic year. These indicators provided *explanatory indicators* for the study because we could use them to help us develop an explanatory model of teachers' pedagogical ICT-use. Table 2.1 lists the set of indicators targeted in the teacher questionnaire.

The 2006 study sampled two populations of teachers: the Grade 8 mathematics and the Grade 8 science teachers from the participating education systems. One important assumption in the design of the study, as indicated in the description of the conceptual framework, was that teachers' decisions on whether and how to make use of ICT in their teaching depend not only on the nature of the school subject taught, but also on the characteristics of the students taught. The research team took great care while designing the questionnaire to ensure that when teachers answered questions related to the core and supplementary indicators, their answers referred to a specific class they were teaching in the school year the survey was conducted. This process meant random selection of a target class for each of the teachers sampled in the study.

The teacher questionnaire began with questions about the target class so that, in addition to providing information about the class their answers referred to, teachers would have a clear focus on that class when answering the later questions. However, although the teacher questionnaire asked teachers to provide information on their target class, no attempt is made to analyze these data in this report, as they are not a core component in the conceptual design of the study. These data were primarily collected to focus teachers on a specific class when responding to questions about their classroom practices. Nonetheless, secondary analyses that include target-class information may add useful insights to our understanding of teachers' ICT-use in different class settings.

Table 2.1 Indicators included in the teacher questionnaire and the corresponding question number

Indicator type	Nature of indicators	Q. no.
Target class information	• Class size • Gender mix • Curriculum track • Extent of student absenteeism • Proportion of students whose native language was the same as the language of instruction • Hours of scheduled class time on the sampled subject • Students' ICT-competence	T1–T7
Core indicators	• Curriculum goal orientation	T8
	• Overall teacher-practice orientation • ICT-using teacher-practice orientation	T14
	• Overall student-practice orientation • ICT-using student-practice orientation	T16
Supplementary indicators	• Frequency of occurrence of different teaching and learning activities • Whether ICT was being used in different teaching and learning activities	T9
	• Location of time and space for teaching and learning activities	T10–T13
	• Assessment practices • ICT and learning resources used	T15
	• Perceived impact of ICT on teachers and students	T17
Explanatory indicators	• Teachers' self-reported ICT-competence	T19–T20
	• Teachers' vision for ICT-use in teaching in the coming school year	T21
	• Obstacles to pedagogical use of ICT	T22
	• Availability of and participation in professional development courses in ICT	T23
	• Perceived presence of community of practice in the school	T24

2.3.2 *Teacher questionnaire (optional component)*

The international option in the teacher survey aimed to gather descriptions from teachers of what they considered to be satisfying experiences when using ICT in their teaching. For this reason, teachers were asked to indicate "whether they used ICT once a week or more in the target class" or whether they "used ICT extensively in the target class during a limited period during the year (e.g., in a project)." Teachers whose responses satisfied at least one of these two criteria were asked to provide a brief description of one pedagogical practice involving ICT that they had found particularly satisfying. The teachers were also asked to respond to three multiple-choice questions that sought their views on these matters:

- Whether the use of ICT in this pedagogical practice contributed to changes on a list of students' outcomes in the target class;
- Whether the use of ICT in this pedagogical practice contributed to changes in the teaching of the target class as listed in the question; and
- Who was the main actor (person) in initiating specified aspects of teaching and learning in this pedagogical practice.

The specific items included in these three questions were designed on the basis of descriptions of how pedagogical practices emerging in the information society might differ from those commonly found in the industrial society (Voogt, 2003).

2.3.3 School questionnaires

Because the concepts addressed at the school level concerned policy-related and school-contextual as well as technical ICT-related issues, the SITES 2006 researchers decided to create two school-level questionnaires. The first contained questions appropriate for school principals and so was called the *principal questionnaire*. The second focused on technical issues and was called the *technical questionnaire*. The final version of the questionnaire for school principals contained 34 questions covering 222 variables and was estimated (on the basis of the pilot tests) to take roughly 20 minutes to answer. The final version of the technical questionnaire contained 19 questions addressing 115 variables, and was estimated to take 15 minutes to complete.

So that answers would reflect the information sought, Question 3 required the inclusion of indicators of school-level conditions. One of the main questions addressed in SITES-M2 (Kozma, 2003) and other studies regarding pedagogy and ICT was, "Which conditions are likely to lead to sustainable development?" The information obtained from SITES-M2 and these other studies (e.g., Jones, 2004; Scrimshaw, 2004) indicated that, next to conditions at the teacher level (such as confidence, level of access, lack of time, resistance to change), conditions at the school (and even the supra-school) level are crucial for initiating and implementing sustainable developments (Owston, 2003).

In general, it is fair to state that the school climate should be one that stimulates and supports teachers to make changes in their pedagogical approaches. More specifically, after an initial stage of orientation at the start of school-wide reforms, a common vision should be established among the main players (e.g., teachers and school management) about desired pedagogical approaches and the role of ICT in the school. The development of such a vision requires serious efforts from the school leadership—effort that, for instance, involves teachers in decision-making about future directions, stimulates staff development, facilitates well-organized technical and pedagogical support, and so on.

Just as it is often argued that individual teachers cannot bring about a sustainable school-wide change, it is increasingly believed that individual schools cannot bring about system-wide change. The vision held by schools therefore needs to be consistent with external policy, which includes ensuring that policy visions are operationalized through the intended curriculum, examination regulations, and the like (Owston, 2003). If teachers need to change their behavioral repertoire (for instance, by adjusting their roles or by adopting new didactical approaches), they need to be trained, which means the school leadership (with the backing of school external forces, such as the ministry of education) needs to facilitate teachers' participation in professional development courses (be they inside or outside the school).

When change concerns the use of ICT, it is important that teachers receive technical support as needed. It is particularly important that this support is immediately available during the lessons in which ICT is used. If it is not, teachers quickly turn away from using ICT. Schools therefore need to organize support in such a way that immediate help is available. The same holds for pedagogical support. Although the immediacy of pedagogical support is not so pressing as it is for technical support, teachers often confront new problems when deviating from the traditional whole-class model of teaching and learning. For instance, the assessment of group processes and products brings challenges to the traditional practice of assessing individual achievement. Another obvious condition for ICT-use is the availability and accessibility of necessary equipment and connectivity. This condition is therefore also an important one to examine.

Table 2.2 summarizes the school-level conditions mentioned above (vision, infrastructure, staff development, support, management, and organization) and operationalized in the two school-level questionnaires.

2.3.4 The national context questionnaire

The cultural and national policy contexts within which ICT is embedded in education vary widely, a consideration that is well documented in the many national reports of previous IEA studies and itemized in the anthology by Plomp, Anderson, Law, and Quale (2003). These studies found that education-system characteristics help us understand trends in school ICT-policy and teaching pedagogy. While the aggregation of school and teacher reports gives us summary glimpses of cultural and policy differences across education systems, systematic collection of key descriptors at the country level provides us with a more comprehensive characterization of the policy context within which to interpret the survey findings from the school and teacher questionnaires.

It was for this reason that the SITES 2006 research team conducted a questionnaire survey of the study's national research coordinators (NRCs). The survey instrument used was called the *national context questionnaire* (NCQ), and it was administered online by the IEA Data Processing and Research Center in the last quarter of 2006. The NRCs were asked to consult with policymakers in their respective ministries of education and with other experts when answering the questions. The questionnaire included both open-ended and close-ended questions on topics related to centralization of educational decision-making, teacher development and certification requirements, and recent trends in policies for ICT in education.

2.3.5 The instrument design process

The design of the SITES 2006 study was a collaborative process that involved valuable input from the NRCs from all the participating systems. Draft field-trial and main-study instruments were reviewed during the NRC meetings with the aim of improving the quality of the instruments. The NCQ was also constructed in conjunction with several rounds of suggestions from the NRCs. The contributions of the NRCs to the research design are gratefully acknowledged.

Table 2.2 Summary of the contents of the school questionnaires

Concepts addressed in the school questionnaires	Description
Infrastructure	• Availability of ICT-hardware (types of computers, local area network, internet connections, electronic whiteboards, etc.) • Availability of software (general and subject-specific software, learning management systems, assessment tools, etc.) • Infrastructure needs and problems
Pedagogical practice	• Extent to which lifelong-learning practices present in the school
Vision	• Vision of the school management with regard to pedagogy and ICT, covering three dimensions: traditional, lifelong learning, and connectedness
Staff development	• Encouragement or requirements for teachers to acquire knowledge and skills with regard to pedagogical practices and the use of ICT • Priorities for school staff to acquire ICT-competencies • Ways that teachers in the school had acquired knowledge and skills for using ICT in teaching and learning • Availability (school-based and/or externally) of ICT-related courses
Support	• Persons involved in providing support and the amount of support time they provide • Extent to which pedagogical support is available for teachers • Extent to which technical support is available for teachers
Organization and management	• Role of principals in initiating changes • Decision-making responsibilities • Management of change • Stimulation of cooperation among teachers • Promotion of alternative assessment practices

2.4 Sampling

A major design issue in an international comparative study such as SITES 2006 is the selection of quality samples. Only properly selected samples yield unbiased, accurate, and internationally comparable survey estimates. Answering the first and third general research questions described above required collection of data at two levels:

1. *The school level*, involving (i) a principal questionnaire and (ii) a technical questionnaire (to be answered by the ICT coordinator)
2. *The classroom level*, involving a teacher questionnaire to be completed by mathematics teachers and science teachers in the sampled schools.

The research questions addressed by SITES 2006 required data and results reported at the school level and at the teacher level, each in their own right. Two target populations therefore were defined: *the school* *population* and *the teacher population*.

The internationally desired school population was defined as all schools with students enrolled in the target grade, that is, schools with students studying in the grade that represents eight years of schooling, counting from the first year of ISCED Level 1 (OECD, 1999). SITES 2006 targeted two teacher populations: the population of all teachers of mathematics teaching in the target grade, and the population of all teachers of science (or, depending on the education system, biology, physics, chemistry, and/or earth science, if appropriate) teaching in the target grade in the school year in which the survey was conducted.

The sampling design also had to optimize the accuracy of the survey estimates at both levels. A sampling design that would sacrifice the accuracy of the estimates of one level for the accuracy of the estimates of the other level would have been incompatible with the project's purposes. For instance, selecting schools with probabilities proportional to their size and then selecting, per sampled school, a fixed number of teachers would have provided an accurate estimate at the teacher level but generated a large variability that would have decreased the accuracy of the population estimate at the school level. Conversely, selecting schools with equal probabilities would have generated a large variability of the teacher weights.

To overcome these conflicting requirements, size strata were created within each explicit stratum. The formula used to compute the number of schools per explicit stratum constituted a good compromise between an allocation representative of schools and an allocation representative of students (and thus probably of teachers).

The school sample size per country was fixed at a minimum of 400 schools. An effective sample size of 400 schools resulted in the following approximate 95% confidence limits for sample estimates of population means and percentages:

Means:	m ± 0.1s (where "m" is a school mean estimate and "s" is its estimated standard deviation);
Percentages:	p ± 5% (where "p" is a school-level percentage estimate).

Within the sampled schools, mathematics teachers and science teachers were independently and randomly selected[1]. Because the study was mainly interested in ICT-users, the number of teachers to be sampled within each school had to be, in some sense, inversely proportional to the percentage of ICT-users in the school. More precisely, the research team decided to increase the number of teachers to be sampled as the estimated percentage of ICT-users decreased, unless none of the teachers was an ICT-user. The within-school sample size was thus equal to:

- Two teachers per subject for any school in which 76 to 100% of teachers were estimated to have used ICT for teaching over the past year
- Three teachers per subject for any school in which 51 to 75% of teachers were estimated to have used ICT for teaching over the past year
- Four teachers per subject for any school in which 1 to 50% of teachers were estimated to have used ICT for teaching over the past year, and
- Two teachers per subject for any school in which 0% of teachers were estimated to have used ICT for teaching over the past year.

Finally, the design of the teacher questionnaire required the sampled teachers, when answering some of the questions, to refer to a particular class in the target grade that they were teaching during the school year. Hence, for each of the sampled teachers, one of the classes in the target grade taught by that teacher had to be randomly selected *as* the *target class* and this target-class information had to be given to the teacher before he or she began answering the questionnaire.

In summary, the SITES sample design can be described as a stratified two-stage sample, with schools constituting the first level and teachers the second level.

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[1] Italy was an exception in that, in schools, both mathematics and science are taught by the same teacher at Grade 8. Therefore, a random sample of teachers teaching both mathematics and science was selected from the sampled schools. These sampled teachers were then systematically assigned to respond to the questionnaire with respect to whether they were teaching mathematics or science in their target classes.

2.5 The field trial

IEA requires, as part of its quality standard, that a field trial is carried out to test and prepare for the main data collection in all studies it conducts. The survey instruments and the sampling routines and procedures as well as the survey operation procedures, the software, the data-processing, and the data-analysis routines are trialed before the main data collection using a sample from the target population (see Martin, Rust, & Adams, 1999, pp. 45ff.). The results of the field trial are then used to make informed decisions about the main study design and implementation, especially with regard to which questions will be used during the main data collection.

One of the major challenges in large-scale international surveys is to gather data that are comparable between different countries and/or education systems. During the field trial, the survey operation procedures, the software provided to education systems for entering the data, and the survey administration information were tested for suitability in the light of the different contexts and cultural backgrounds of the participating education systems.

The field trial for SITES 2006 was carried out in autumn 2005. Eighteen education systems participated in the trial. They were Catalonia-Spain, Chile, Chinese Taipei, Denmark, Estonia, Finland, France, Hong Kong SAR, Israel, Italy, Japan, Lithuania, Norway, the Russian Federation, Singapore, the Slovak Republic, Slovenia, and Thailand. The full set of instruments was administered to a sample of (usually) 25 schools per education system. The school principal, the ICT coordinator, two to four mathematics and two to four science teachers from each school were asked to participate (the exact number differed, as prescribed by the sampling design described above). Overall, data were received from 370 school principals, 377 ICT coordinators, 779 mathematics teachers, and 729 science teachers in the 18 systems participating in the field trial.

The field trial data were processed at the IEA Data Processing and Research Center (DPC). The procedures for data cleaning intended for use in the main data collection were trialed. This process included, but was not limited to, checking and recoding of inconsistencies between tracking information and information given in the questionnaire, recoding nationally adapted variables according to the information provided by the national research centers to ensure international comparability of the data, and checking for data-entry errors.

The option of online data collection (ODC) was offered to education systems as an additional data-collection mode. To investigate the comparability of data collected using the traditional paper-and-pencil mode and the online mode, a split-half design was implemented in the SITES field trial. Because the comparison between the two data-collection modes showed no significant differences, the ICC decided to offer ODC as an international option to the education systems participating in the main data collection. (The following section provides more information on the ODC option.)

In December 2005, the ICC finalized the main study design. Item statistics provided by the IEA DPC were used to make informed decisions on the final selection and wording for the questions to be included in the main data collection. These proposals and decisions were also discussed with NRCs during the second NRC meeting, and their feedback was taken into account during shaping of the final instruments and survey operation procedures. In general, the field-trial results showed the feasibility of the study's main features, including the instruments.

2.6 Online data collection

The advantages of collecting large amounts of data in international surveys over the internet are evident and substantial in terms of costs and time. However, these factors do not provide grounds in their own right for implementing online questionnaires. What must be proven is that quality, in terms of high participation rates and comparable data irrespective of the data-collection channel, is maintained.

The thematic background of SITES 2006 made it a good candidate for IEA to explore the feasibility of collecting data over the internet in addition to collecting data through the traditional paper-and-pencil response channel. Consequently, the ICC carefully planned the ODC component in SITES and then gradually launched it in a series of well-monitored steps in close cooperation with the participating education systems and experts from late 2004 onwards as a component of the field trial. The findings were than used to determine if ODC could be offered as a non-mandatory international option for the main study.

Methodologically, the main challenges were to ensure isomorphic versions of the instrumentation in both modes, so that the resulting mixed-mode survey could be reliability administered within the existing survey framework and procedures, and the two sets of data subsequently integrated and processed. After a technical try-out designed to identify obstacles connected to the software itself (the IEA *SurveySystem*), including those relating to its implementation in the different browsers and languages that would be used in the survey, a feature-complete software was used for the field trial.

A split-sample design was employed to identify, investigate, and statistically control for possible measurement problems in relation to the data-collection mode, such as response bias and non-response at variable or questionnaire level. The aim here was to determine if the two modes—online and paper-and-pencil—would yield comparable data, thus allowing implementation of both modes in and across countries. Accordingly, one half of the field-trial schools were randomly assigned to the online mode; the other half received paper questionnaires. The major conclusion drawn, based on various statistical and qualitative approaches, was that there were no substantial differences between the data derived from the paper mode and those from the online mode of the kind that would reduce the research team's ability to combine these sets of data and to make joint analyses.

On the basis of the satisfactory field trial results, ODC was offered to the education systems participating in the IEA SITES 2006 main data collection, making it the first study in the history of international comparative educational assessments to apply such a methodology. The study's national centers had to accurately document the required survey mode at the school and individual levels, and it was mandatory for them to check that the schools accepted this mode before sending out materials. The centers were also required to provide fall-back questionnaires to those individuals without internet access and/or required equipment, or who simply refused. The majority of the participating systems (17 out of 22) opted to implement ODC, usually as the default data-collection mode.

2.7 Methodological issues

This section describes some of the more technical considerations relating to the design, analysis, and reporting of the study. Readers interested only in the substantive findings from the study can skip this section, whereas readers wanting more details about the research design, analysis, and associated methodological details should, after reading this chapter, refer to the SITES 2006 technical report (Carstens & Pelgrum, 2008).

2.7.1 Development and reliability of scale indicators

In quantitative studies, scales are often constructed from responses to a number of items in order to provide better indicators for conceptual constructs. Different methods can be used to construct scales. Confirmatory factor analysis (CFA) is widely recognized as a rigorous statistical technique for constructing measurement models designed to confirm or disprove hypothesized underlying latent variable structures (Byrne, 1989). CFA is also used extensively in studies across different fields, such as psychology, marketing, and career counseling (see, for example, Byrne, 1989; Harvey, Billings & Nilan, 1985; Kumar & Sashi, 1989; Marsh, 1985; Thacker, Fields, & Tetrick, 1989). However, a Cronbach's alpha reliability score of 0.5 or above is often considered acceptable for a set of items set as a scale. SITES 2006 used both methods.

Because the three sets of indicators for the overall pedagogical orientations designed for the teacher questionnaire, namely the curriculum goal orientations, teacher-practice orientations, and student-practice orientations, were central to the design of SITES 2006, CFA was used in the pilot and field-trial stages to ensure the questionnaire items designed would deliver indicators that had prima facie construct validity and met the requisite statistical standards.

The factor analysis results for both the pilot and the field-trial studies yielded four factors with acceptable CFA goodness-of-fit statistics for each of the pedagogical-orientation constructs. The four factors were labeled "traditionally important," "collaborative inquiry," "student-centered," and "connectedness." The analysis also revealed a high degree of correlation between the collaborative inquiry and the student-centered-orientation indicators, which allowed the two to be collapsed into one factor, labeled "lifelong learning," in line with the constructs in the conceptual framework presented earlier.

Because the statistical reliability of the indicators for the pedagogical-orientation constructs could depend on context factors at the system level, reliability scores needed to be computed for each participating system to ensure that each met the quality requirements for scale construction. Unfortunately, this procedure could not be satisfactorily performed systematically for each system in the field trial because the sample sizes were small (typically around 40 teachers per system from around 25 schools). All explorations on scale construction therefore were conducted on the entire set of teacher-questionnaire returns from the field trial.

During the final analysis of the main study data, the reliability for each scale indicator was computed for each participating system to ensure that the indicators reported were statistically acceptable for all participating systems. The only instance in which this degree of acceptability was not the case concerned the scales pertaining to the traditionally important orientation, particularly the traditionally important student-practice scale. (We report on this in greater detail in Chapter 5.)

Another limitation encountered in the development of scale indicators was the small number of items that could be used to form a scale. This small number was a consequence of the need to constrain the length of the questionnaire in order to minimize respondent dropout.

For the other indicators in this study, items comprising a scale were either determined a priori or through exploratory factor analysis. Cronbach's alpha reliability was then used to determine the acceptability of the indicator for reporting purposes. It is important to point out that the small number of items comprising each scale meant all indicators were computed using listwise deletion whenever data were missing from among the scale variables. Listwise deletion reduces the probability of bias due to missing data.

2.7.2 Reporting standards for IEA studies

Statistics derived from analyses of survey responses are used to provide estimates of the respective measures of the population sampled. Non-response may introduce a bias in survey outcomes, and the potential bias increases with lower participation rates. IEA requires a participation rate of at least 70% after replacement for the respective statistics to be included in international comparisons. As described in the earlier section on sampling, the research questions that SITES 2006 addressed required that data and results be reported at the school level and at the teacher level, each in its own right. As such, the school and teacher samples were drawn with a two-stage design, which meant that participation rates for results derived from the school questionnaires and from the teacher questionnaire needed to be computed separately.

Non-adherence to survey administration procedures can be another potential source of bias. Teachers may make different pedagogical decisions for classes on the same subject and at the same grade level because of different student characteristics in these classes. Thus, as described in Section 2.2.1, a target class was identified for each of the teachers sampled in the study and indicated clearly on the questionnaire. Unfortunately, the procedure for target-class selection and subsequent indication on the distributed questionnaire was not strictly followed in all schools in some participating systems during the main data collection stage, although this problem was not encountered during the field trial.

IEA guidelines for reporting survey findings require that clear demarcations be made between statistics deemed to be unbiased from those where the bias may not be negligible by presenting these in two distinct lists. This guideline is evident in the presentation of the survey findings in Chapters 4 to 7. Furthermore, whenever the "international mean" is reported in this publication, it is important to note that the mean was computed on the basis of responses collected from systems where the respective statistic was deemed to be unbiased.

2.8 Summary

SITES 2006 was developed as an international comparative study that sought answers to the following issues:

1. How and to what extent ICT was being used in the context of the overall pedagogical practices of representative samples of Grade 8 mathematics teachers and Grade 8 science teachers?
2. The extent to which the preconditions for different pedagogical practices and ICT use were present in a representative sample of schools, and
3. The extent to which these preconditions, the pedagogical practices, and ICT-use were related.

The main instruments used in this study were a survey of mathematics teachers and science teachers and surveys of principals and ICT-coordinators in schools, supplemented by a national-context questionnaire designed to provide pertinent information at the system level. The research questions primarily addressed, through analysis of quantitative indicators supplemented by qualitative analysis, teachers' descriptions of their satisfying experiences when using ICT in their teaching.

Consistent with our view that pedagogical practice and ICT-use should be understood within the school- and system-level contexts, the findings from this study at the system level are reported first, followed by reports of the findings from the school-level questionnaires. Findings from the teacher questionnaire are reported in three separate chapters, the first of which addresses the first research question by describing the mathematics teachers' and the science teachers' pedagogical practices and ICT-use. The second chapter focuses on the teachers' characteristics and how these affected their pedagogical use of ICT, and the third, which addresses the second research question, covers the teachers' reports of satisfying pedagogical practices that involved use of ICT. The eighth chapter in this book pulls the findings together in the form of explanatory models that seek to link the findings from the different levels.

3

National Contexts

Ronald E. ANDERSON and Tjeerd PLOMP

As stated in Chapter 1, the principal contextual question of interest in SITES 2006 concerned the system factors associated with different pedagogical approaches and ICT-use within the respective participating education systems. This chapter therefore focuses on the education systems that participated in SITES 2006 and their attributes. The contexts of each of the 22 education systems are characterized in order to aid interpretation of the findings reported in later chapters in general and to evaluate the extent to which system characteristics help us understand trends in school ICT-policy and in teaching pedagogy in particular.

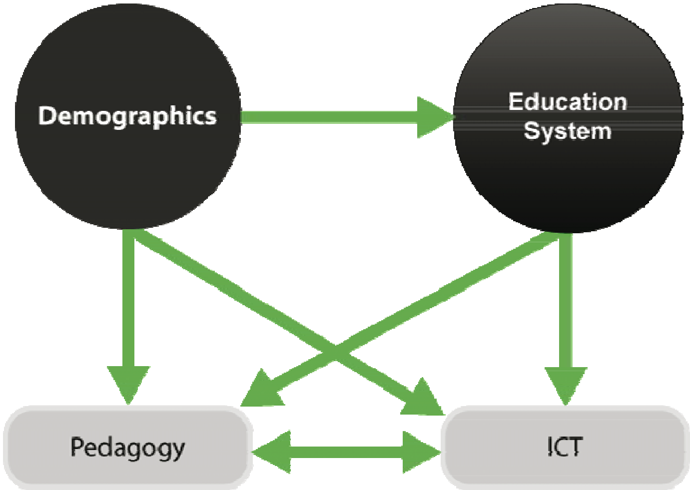
The chapter utilizes a conceptual structure that divides the system-level contextual questions and variables considered in this chapter into four clusters or spheres: demographics, education system, pedagogical trends, and ICT-related policies (see Figure 3.1 and refer also to Section 2.2 in Chapter 2). Each of these spheres is discussed below. The data for these spheres derive primarily from the national context questionnaire (NCQ) (answered by the SITES national research coordinator [NRC] for each country or education system). However, we also used several demographic and technology indicators from the *Human Development Report 2006* (United Nations Development Program, 2006).

All four contextual spheres are conceived in this chapter as attributes of education systems. Pedagogy and ICT in learning are, of course, processes that occur primarily at the levels of the classroom and school, but the general trends or patterns that emerge in relation to these processes can be considered characteristics of the overall system of education. This assertion aligns with the perspective given in Plomp,

N. Law et al. (eds.), Pedagogy and ICT Use in Schools around the World, 37–66.

Anderson, Law, and Quale (2003).

Figure 3.1 Four spheres of contextual factors



3.1 Research questions relating to the four spheres

3.1.1 Demographics

The system-wide demographic and education cultural indicators obtained from the UNDP *Human Development Report 2006* included population, urbanization, income, income inequality, education level, and investment in education. Our aim here was to explore the extent to which these indicators predicted ICT-related structure and pedagogy in education. The research question we posed in regard to this sphere was: *Among the education systems studied, what are the distributions of indicators (and how do they differ) in terms of population, GDP, income inequality, cell phone users per 1,000 of population, and internet users per 1,000 of population?*

The analysis is limited to only a few demographic indicators selected on the basis of prior research that suggested they might relate strongly to patterns of diffusion of ICT within education. ICT tends to be costly; as such, financial indicators were also of interest. Finally, we considered that concentrations of internet use and cell phone use might indicate the capabilities of individuals to deal with such technology easily.

3.1.2 Structure of the education systems

We identified four sets of indicators for this sphere: (i) education system investment and output; (ii) centralization in terms of funding sources and curricular components; (iii) professional development requirements for teachers; and (iv) mathematics and science curriculum components. Kozma's (2003) case study data support the importance of these forces. In exploring the role of these factors, we were guided by this broad research question: *What are the distributional patterns across education systems in terms of general education level, investment in education, professional development of teachers, centralization of curricula and funding, and mathematics curriculum and science curriculum components?*

3.1.3 Pedagogy

The NCQ instrument contained a number of questions relating to trends in pedagogical practice within each education system as a whole. Some of these focused on instructional reform or change. Indicators of teacher preparation were also included under pedagogy. For these questions or indicators, we were primarily interested in the distribution of pedagogical indicators across education systems.

3.1.4 ICT-related policy and activities

As with the sphere of pedagogy, ICT was a major dimension of interest, primarily in terms of its interaction with pedagogy. We decided to explore the following general question: *To what extent do education systems implement ICT and also combine it with pedagogical reform*? The relevant indicators included ICT-related policy and practice within education.

3.2 Methods overview

As noted, the principal instrument used to gather the information needed to answer these questions was the NCQ, which was administered to the SITES NRCs. The questionnaire was administered online by the IEA Data Processing Center in the last quarter of 2006. The NRCs were asked to consult with policymakers in their respective ministries of education and with other experts when answering the questions. The questionnaire included both open-ended and closed-ended questions; the analysis in this chapter integrates both types of information. More methodological details related to indicators and the analysis can be found in Chapter 2 of the SITES 2006 technical report (Carstens and Pelgrum, in press).

Our analysis here is constrained to a single level in which the education system is the unit of analysis. While we have some rudimentary indicators of pedagogical orientation and ICT-use at the system level, these are drawn from answers to the NCQ questions and so do not have the benefit of the more extensively measured indicators based on the principal or teacher surveys and utilized in later chapters. Further, the analysis is necessarily limited by the inclusion of only 22 education systems, 16 of which are nations and six of which are within-country regions or distinct administrative units. While we refer to them all occasionally as "countries," generally we follow the IEA convention of referring to them as "education systems." The systems were not randomly sampled, so our utilization of statistical inference is of necessity informal, with only descriptive statistics and qualitative results reported in this chapter.

The reporting of this analysis and its findings is divided into two overall sections: within-sphere and between-sphere. The former focuses on descriptive distributions and qualitative data while the latter consists primarily of explanatory or predictive analyses. These sections are followed by a final, integrative section labeled "Conclusions". The findings in the within-sphere section are reported for each sphere one at a time: demographics, structure, pedagogy, and ICT.

3.3 Within-sphere (univariate) findings

3.3.1 Pedagogy

Considerable demographic diversity is evident across the 22 education systems (see Table 3.1). At the time of the SITES 2006 survey, the populations of these countries ranged from 1.3 million (Estonia) to 144 million (Russia). Urbanization ranged from 32% for Thailand to 100% for Hong Kong SAR and Singapore. Per person GDP started at about US$8,000 in Thailand and ranged through to about US$38,000 for Norway. We measured income inequality by subtracting the average per capita income of the lowest-earning 10% or poorest members of the population from the average per capita income of the top-earning or richest 10%. That calculation produced a gap of US$4,500 for Japan (the lowest of the 22 education systems) and a gap of US$40,600 for Chile (the highest difference). Most of the participating systems had an inequality gap within the range of US$7,005 to US$12,500.

Cell phone penetration or use also showed considerable spread, with Thailand and South Africa at the bottom end of the range (about 430 cell phones per 1,000 adults). Hong Kong SAR, Israel, and Italy had just over 1,000 cell phones per 1,000 adults—a figure that implies some people had more than one mobile phone. Internet penetration was lower. The system with the fewest internet users was South Africa (78 internet users per 1,000). The system with the most was Denmark (696 per 1,000).

3.3.2 Structure of the education systems

Table 3.2 lists variables that describe the education systems as a whole. The first two variables were obtained from the UNDP data, as was the demographic information. The education level index (column u7) is the average of two percentages: adults who are literate and school-age children in school. As can be seen, most education systems in the study had quite high percentages for both factors. The highest were Denmark and Norway with 99%; the lowest were Chinese Taipei, South Africa, Thailand, and Hong Kong in the 80s. The remaining indicators presented in this section are based on data from the NCQ. Some are simply the answers to one or more questions; others are an aggregation (usually summation) of items from the NCQ.

1. Central versus local control (q1–7)

The first two indicators measured centralization of control and funding. When the NRCs were asked at what level (central government, provincial and/or regional government, district and/or local government, non-statutory and/or professional body, "schools are free to decide," and "other") various functions were set (e.g., system structure [q1], examinations [q2], and certification requirements [q3]), almost all of the them specified the central level. The only major exceptions to this pattern were the Canadian provinces and Catalonia-Spain.

More differentiation became evident with regard to control of curriculum and funding. According to the NRCs' reports, more than half of the education systems give primary control of funding for schooling to the central or provincial governments (entered as a "yes" in Table 3.2). Although the education systems were classified as either central or local, many of them provide some funding at both levels. For example, the

Table 3.1 Demographic factors by country (education system)*

Education system	(u1) Pop. in millions	(u2) % Urbanization	(u3) GDP per capita (in US$)	(u4) Income inequality (in US$)	(u5) Cell phone users per 1K	(u6) Internet users per 1K
Alberta Province, Canada	3.3	70	29,263	9,400	469	646
Catalonia, Spain	7.2	82	29,645	10,300	905	336
Chile	16.1	87	10,874	40,600	593	267
Chinese Taipei	23.0	60	12,941	18,400	677	273
Denmark	5.4	86	31,914	8,100	956	696
Estonia	1.3	69	14,555	6,500	931	497
Finland	5.2	61	29,951	5,600	954	629
France	60.3	77	29,300	9,100	738	414
Hong Kong SAR	7.0	100	30,822	17,800	1,184	506
Israel	6.6	92	24,382	13,400	1,057	471
Italy	58.0	68	28,180	11,600	1,090	501
Japan	127.9	66	29,251	4,500	716	587
Lithuania	3.4	67	13,107	10,400	996	282
Moscow, Russian Federation	10.9	79	9,902	13,700	617	211
Norway	4.6	77	38,454	6,100	861	390
Ontario Province, Canada	12.5	82	32,663	9,400	489	689
Russian Federation	143.9	73	9,902	6,440	517	111
Singapore	4.3	100	28,077	17,700	910	571
Slovak Republic	5.4	56	14,623	6,700	794	423
Slovenia	2.0	51	20,939	5,900	951	476
South Africa	47.2	59	11,192	33,100	428	78
Thailand	63.7	32	8,090	12,600	430	109

Notes:

* Primary source of all "u" indicators was the *UNDP Human Development Report, 2006*
Except where otherwise noted, the statistics were based upon 2004

(u1) Total population in millions
(u2) Percent of population in urban areas
(u3) Gross Domestic Product per person in US$
(u4) Income inequality is measured by subtracting the average per capita income of the lowest-earning 10% of the population from the top-earning 10% (figures in US$)
(u5) Cell phone users are the number of users per 1,000 population in 2003
(u6) Internet users are the number of user per 1,000 of population in 2003.

primary funding source in Lithuania is the local authority, which funds school infrastructure (buildings, non-teaching staff, heating, communications, etc.), but the central government provides the secondary source by funding the "student's basket" (teacher salaries, teaching materials, and teacher training). France has these sources of funding as well as funding from companies and families. In Estonia, funds are given to the municipalities, which have considerable autonomy in allocating them within the educational budget. In the Canadian provinces, funds are given to school boards. Danish schools funds are given to the municipalities, which have considerable autonomy (both public and private) and are mainly financed by municipalities, but the municipalities receive a block grant from the central government. The grant is not earmarked for a specific purpose. Eight of the 22 education systems reported central control of funding but decentralized determination of the curriculum.

With regard to central or provincial control of curriculum components (e.g., attainment targets, textbook lists, and teaching methods), the education systems were again evenly divided, with slightly fewer than half indicating little control of curriculum elements. In Norway, the new reform, "Knowledge Promotion," implemented in schools in the fall of 2006, grants a higher degree of freedom at the local level with respect to teaching materials and the methods of classroom instruction. Compared to the old compulsory curriculum, the reform places a stronger emphasis on attainment targets and skill preparation. In Spain, the central government establishes around two thirds (65%) of the curriculum content for compulsory education. However, in Catalonia, as well as in other regions of Spain with their own official language, this percentage drops to 55.

2. Promotion of students in the target grade (q10, Table 3.2)

Another question (q10) asked the NRCs to specify the criteria their respective education system used to promote students in the target grade to the next grade level. The answer alternatives were (a) national examination, (b) school internal examination, (c) oral and/or written examinations throughout the school year, (d) portfolio of student work, and (e) other.

The q10 column in Table 3.2 contains the letters of all the answers selected. A maximum of three options could be selected, so one to three letters appear in that column. The most common answer was "c", for oral and/or written examinations throughout the school year. However, "b" for internal examination was also quite often selected, as was "bcd," for all three of those answers.

In Chinese Taipei, the NRC reported that every student is promoted to the next grade level after finishing his or her present grade, unless under some special conditions, such as a request from parents. Chinese Taipei's compulsory education system (Grades 1 to 9) does not fail students. Remedial activities are carried out to help students who

Table 3.2 Structural factors by education system

Education system	(u7) Index of education level	(u8) Educ. $ divided by GDP	(q4) Centralized funding
Alberta Province, Canada	0.97	5.3	yes
Catalonia, Spain	0.98	4.5	yes
Chile	0.91	3.7	yes
Chinese Taipei	0.88	4.7	no
Denmark	0.99	8.4	no
Estonia	0.97	5.7	no
Finland	0.99	6.5	no
France	0.97	6.0	no
Hong Kong SAR	0.88	4.7	yes
Israel	0.95	7.3	yes
Italy	0.96	4.9	.
Japan	0.94	3.7	no
Lithuania	0.97	5.2	no
Moscow, Russian Federation	0.95	3.9	yes
Norway	0.99	7.7	no
Ontario Province, Canada	0.97	5.6	yes
Russian Federation	0.95	3.7	yes
Singapore	0.91	5.7	yes
Slovak Republic	0.92	4.4	yes
Slovenia	0.98	6.0	yes
South Africa	0.80	5.4	yes
Thailand	0.86	4.2	yes

Notes:

(u7) "Education level" averages the country's literacy rate (percent of adults literate) with the gross enrollment of primary through tertiary

(u8) Educ. $" is the total public spending in US$ for K-12 education divided by the GDP (Gross Domestic Product)

(q4) Central funding combines responses from three NCQ questions (4, 5 & 6) by coding "yes" if primary funding source is national or provincial; otherwise, it is coded "no". Non-responses were coded "."

perform poorly in the assessment process. Similarly, the Danish public school system is not examination oriented. The main regulation is that a student attends a class with students of the same age. The final decision concerning progress is taken by the parents, although they are guided by the teachers and the school. In Ontario Province, teachers use a wide range of assessment and evaluation strategies throughout the year; decisions related to promotion are determined at the local school level by principals and teachers in consultation with parents. The schools, using a standard provincial report card, give students' grades to parents three times a year.

Table 3.2 Structural factors by education system (Continued)

Education system	(q7) Centralized control of curriculum	(q10) Criteria for promotion	(q11) No. of subjects with standards
Alberta Province, Canada	yes	bc	none
Catalonia, Spain	yes	b	some
Chile	yes	ce	none
Chinese Taipei	yes	e	none
Denmark	yes	e	some
Estonia	no	cd	all
Finland	no	c	none *
France	yes	b	all
Hong Kong SAR	no	c	some
Israel	no	b	all
Italy	yes	ce	all
Japan	no	c	all
Lithuania	no	c	none
Moscow, Russian Federation	no	e	all
Norway	yes	e	none
Ontario Province, Canada	no	c	some
Russian Federation	no	bcd	all
Singapore	yes	bcd	some
Slovak Republic	yes	bcd	all
Slovenia	no	c	all
South Africa	no	bcd	some
Thailand	no	bcd	all

Notes:

(q7) Central control of curriculum components was based upon question NCQ7; coded "yes" if country has central or provincial control of three or four curriculum components, but coded no if control over only one or two components

(q10) Criteria for promotion of students in target grade to next grade: (a) "national examination"; (b) "school internal examination"; (c) "oral and/or written examinations throughout the school year"; (d) "portfolio of student work"; and (e) "other"

(q11) Number of subjects with attainment standards for target grade: (a) "none"; (b) "all school subjects"; and (c) "only some subjects"

* Finland has defined national aims for learning but does not consider them to be attainment standards.

In Catalonia-Spain, a student can be promoted to the next grade despite failing up to two subjects. In Finland, students can be promoted to the next grade level even if they fail some school subjects. Here, the students are evaluated to ensure they have the skills required to manage the program of study at the next grade level. In Singapore, students must pass English language to be promoted to the next grade level. The Israeli procedure for evaluating the progress of students before deciding on their promotion to the next grade level is determined by their grade average at each half or term of the school year. All students in the target grade must attain pre-defined standards in all school subjects in order to be promoted to the next grade level. Fifty-five out of 100 is the threshold (i.e., the passing grade). However, higher thresholds for failure can be locally defined. In addition, some schools provide students with opportunity to study during the summer holidays and/or take a test, the passing of which enables their promotion to Grade 9.

3. Attainment standards (q11, Table 3.2)
The NCQ asked (q11) if the education system had attainment standards for subjects in the target grade in terms of one of three answer alternatives: (a) none, (b) all school subjects, and (c) only some subjects. As evident in Table 3.2, 10 education systems at the time of SITES 2006 had attainment standards for all subjects in the target grade, six had these standards for some of the subjects, and six did not apply standards to any subjects. Of the six education systems with "some" subject standards, two (Chinese Taipei and South Africa) applied attainment standards to mathematics, science, and mother tongue Ten of the 22 education system NRCs reported attainment standards for all three core subjects: mathematics, science, and mother tongue.

3.3.3 Pedagogy and curriculum

The NCQ included a number of questions on pedagogical aspects related to teacher preparation, changes in pedagogical practices over the previous five years, and new pedagogies using ICT. There were also a number of questions on aspects of the mathematics and science curricula.

1. Teacher preparation (q16–19)
Several of the pedagogy indicators dealt with teacher development; the results appear in Table 3.3. The first question relating to this indicator (q16) asked, "*What is the normal requirement for being certified as a teacher*?" The answer options for the question were (1) post-secondary diploma and/or certification in an education field, (2) any post-secondary degree, (3) any post-secondary degree plus certificate in education, (4) other, and (5) requirements defined at local or school level only. The count of answer options selected was 3, 1, 14, and 4 for answers 1, 2, 3, and 4 respectively. It is clear from Table 3.3 that the certification procedures in some education systems are more stringent than in others. Finland and the Slovak Republic require a master's-level university degree for anyone teaching Grade 7 and higher; all teachers in their compulsory schools have to take teachers' pedagogical studies and basic educational

or disciplinary studies as part of this degree. Israel requires a B.Ed. degree plus one to two years of "coaching" experience in teaching. Thailand requires a one-year internship beyond the four-year degree program for teachers of science or mathematics, a prerequisite that does not apply to teachers of other subjects.

With regard to specific ICT-requirements for teacher certification, q17 asked, "*Are there ICT-specific requirements for being certified as a teacher*?" The answer options were (a) none, (b) technical competence, (c) subject teaching with ICT, (d) ICT-based pedagogy, (e) others, and (f) requirements defined only at local level. Even though the question format required respondents to check all answer options that applied, the NRCs each checked only one option, with the exception of the NRC from Catalonia. Although the NRC for Catalonia stated that most schools in the system have no ICT-requirements for teachers, he noted that private schools can and do specify such requirements. Over half (15) of the education systems reported "none," two reported "technical competence," none reported "subject teaching with ICT," three reported "ICT-based pedagogy" (Japan, Lithuania, and Singapore), and only Israel chose "requirements defined at the local level". Thus, only five education systems had an ICT-specific requirement for certification. However, several other systems said that such preparation was encouraged but not required.

A third indicator of teacher preparation is professional development. Question 18 asked, "*Are qualified teachers in the target grade required to undertake regularly any in-service and/or professional development activities on any of the following [seven] aspects?*" The indicator was defined as the number of in-service or professional development (PD) components (out of seven) required for teachers. Three of the components dealt with ICT-skills, one was defined as a "major subject area of teaching," and the remaining three concerned pedagogical strategies. The majority of the education systems (13) reported that their teachers were not required to engage regularly in any of the seven PD activities listed. At the other extreme, two countries (Japan and Thailand) reported five or more requirements; the remainder reported one, two, or three requirements. Israel, Catalonia, Lithuania, and Ontario Province all said that while no components were required, many teachers did undertake this training. Thus, even though some of the systems had fairly demanding pre-service and certification requirements, centralized in-service requirements were generally absent at the central level.

Table 3.3 Pedagogical factors by education system

Education system	(q16) Teacher cert. required	(q17) ICT-specific req. for certification	(q18) Sum of req. teacher PD
Alberta Province, Canada	3	e	0
Catalonia, Spain	3	a	0
Chile	1	a	0
Chinese Taipei	3	a	0
Denmark	1	a	0
Estonia	3	b	2
Finland	4	a	0
France	2	a	7
Hong Kong SAR	3	a	0
Israel	3	f	0
Italy	4	a	0
Japan	3	d	6
Lithuania	3	d	0
Moscow, Russian Federation	3	a	3
Norway	1	a	0
Ontario Province, Canada	3	a	0
Russian Federation	3	a	2
Singapore	4	d	3
Slovak Republic	4	a	0
Slovenia	3	a	.
South Africa	3	b	1
Thailand	3	a	5

Notes:

(q16) Selection of teacher-certification requirement options: (1) "postsecondary diploma and/or certification in education field"; (2) "any post-secondary degree"; (3) "any post-secondary degree plus certificate in education"; (4) "other"; and (5) "requirements defined at local level only"

(q17) ICT-specific requirements for certification: (a) "none"; (b) "technical competence"; (c) "subject teaching with ICT"; (d) "ICT-based pedagogy"; (e) "others"; and (f) "requirements defined only at local level"

(q18) Sum of required teacher PD (professional development) is the number of PD components (out of 7) required of teachers.

The fourth indicator of teacher preparation was represented by q19, which asked, *"Do any government agencies subsidize in-service training or professional development courses for teachers in any of the following areas?"* The areas listed were (a) ICT-skills, (b) use of ICT in subjects, (c) use of ICT in administration, and (d) use of ICT for new approaches in learning. The letter for each of the four options selected is evident in the q19 column of Table 3.3. As can be seen, a large majority of the systems (17) reported subsidies of all four types. In addition, all the systems, except for the two that did not answer the question at all, chose the

Table 3.3 Pedagogical factors by education system (Continued)

Education system	(q19) Subsidy for PD and in-service	(q20j) Index of increased new pedagogical practices	(q29) No. of new pedagogies using ICT
Alberta Province, Canada	abcd	19	5
Catalonia, Spain	abcd	19	0
Chile	abcd	12	4
Chinese Taipei	abcd	17	3
Denmark	abcd	15	4
Estonia	abcd	20	0
Finland	abcd	14	3
France	abcd	14	4
Hong Kong SAR	abcd	15	0
Israel	abcd	20	0
Italy	abcd	23	0
Japan	ab	14	0
Lithuania	acd	23	0
Moscow, Russian Federation	abcd	14	0
Norway	abcd	19	5
Ontario Province, Canada	.	20	0
Russian Federation	a	14	0
Singapore	abcd	23	4
Slovak Republic	abcd	14	1
Slovenia	abcd	.	0
South Africa	-	20	0
Thailand	abcd	19	5

Notes:

(q19) Government subsidy of in-service or professional development for teachers in: (a) "ICT-skills"; (b) "use of ICT in subjects"; (c) "use of ICT in administration"; and (d) "use of ICT for new approaches in learning"

(q20j) Increased new pedagogical practices are the sum of the series of six questions asking if each of six aspects of non-traditional practices had decreased or increased during the past five years (NCQ20, items j to o) scored on a scale of (1) decreased; (2) no change; (3) increased a little; and (4) increased a lot

(q29) The number of new (non-traditional) pedagogies using ICT was based upon NCQ29 (items b to f).

option, "ICT-skills". Hence, despite there being no centralized specification of ICT-skills for teachers, appropriate ICT-based training was being subsidized and was sometimes available for teachers in most of the participating systems. Several systems reported the ministry of education as the agency responsible for providing training. One exception was Singapore, whose NRC reported that the ministry gives funding to the individual schools, which can then use this money to contract for training as they see fit.

2. Change in pedagogical practices (q20 j–o)

The principal way that we attempted to measure change in the pedagogical practices within the past five years was with a six-item (items j through o) subset in question NCQ20 (indicator q20j). The measure is thus the sum of a series of six questions (NCQ20, items j to o) that together asked the respondents to state if each of six aspects of non-traditional practices had decreased or increased over the previous five years. The items in the scale (q20j in Table 3.3) included the following types of emerging pedagogies: individualized learning, inquiry-based tasks, collaboration for project-based learning, inter-classroom collaboration, inter-school collaboration, and international collaborative projects. The categories for each item were (1) "decreased," (2) "no change," (3) "increased slightly," and (4) "increased a lot." The sum score ranged from 12 for Chile to 23 for Lithuania, Singapore, and Italy. Increases over the past five years did not necessarily correlate with prior change; some of the education systems at the low end had already made substantial changes in early years. The median increase for the 22 education systems was 20, which implies that the majority of the systems had increased their use of non-standard pedagogical practices at least slightly during the previous five years.

3. New pedagogies using ICT (q29)

Question NCQ29 asked if the education system had a system-wide program at the target grade for each of several new pedagogies using ICT. A sum scale was formed by adding the number of new (non-traditional) pedagogies with ICT (q29). The five new pedagogies using ICT were (b) student-centered pedagogies, (c) online learning, (d) "connecting with other schools and cultures," (e) "collaborative team learning," and (f) "communication and presentation." As Table 3.3 shows, 12 education systems did not have a system-wide program in relation to any of these attributes. Alberta Province, Norway, and Thailand, however, reported programs with all five characteristics.

4. Mathematics and science curricula (q12, 14)

This topic is not represented in the tables because all the education systems reported having a system-wide curriculum in both mathematics and science at the target-grade level. Each relevant question (namely NPQ12 and NPQ14) was followed by a multi-part question that asked the respondents to assess each system's emphasis on each of the following pedagogical approaches: (a) mastering basic skills, (b) applying mathematics in real-life contexts, (c) communicating about mathematics, and (d) integrating mathematics with ICT. The rating scale for each of the four parts was a four-point scale with the labels none, very little, some, and a lot.

Nearly all respondents indicated that their country placed some emphasis on each of the four pedagogical approaches for both mathematics and science. However, for both subjects, the highest emphasis rating was given differentially for the pedagogies. According to the responses, most education systems gave "a lot" of emphasis to "mastering basic skills," about half of the systems gave that emphasis to "applying (mathematics or science) in real-life contexts," and about a quarter gave high emphasis to "communicating about mathematics." Only two of the 22 systems gave high emphasis to "integrating (mathematics or science) with ICT." Remarkably, the response distributions for the mathematics and science emphases (q13 and q15) were nearly identical.

3.3.4 ICT

The NCQ included a number of questions relating to expenditure for ICT in education and to policies and practices on the use of ICT. These are discussed in this section. The next section reports on the programs designed to develop "21st-century skills" that the education systems had in place for the target grade.

1. Increased spending on ICT

The NCQ used a subset of items in question NCQ20 (q20a in Table 3.4) to determine if education systems had increased their spending on ICT within the past five years. The measure was the sum of scores on a series of seven questions (NCQ20, items b to h) that asked if spending on each of seven aspects of non-traditional practices had decreased or increased during the past five years. The scale items included these ICT-related expenditures: internet connections and networking, classroom-based ICT, instructional technology support, professional development related to ICT in teaching, and school-leadership development for ICT in learning. The categories for each item were (1) decreased, (2) no change, (3) increased slightly, and (4) increased a lot. The sum score ranged from 9 for Chile to 28 for Italy. Also at the low end were Hong Kong and Singapore and at the high end Catalonia, Finland, and Norway.

Increases in spending for ICT during the previous five years did not necessarily correlate with prior increases; some of the education systems at the low end had already spent a considerable amount on ICT in earlier years. The median increase for the 22 education systems was about 20, which implies that the majority of the systems had increased their expenditure on ICT at least slightly during the preceding five years.

2. System-wide ICT in education policy

When asked if a system-wide ICT in education policy existed, 20 of the 22 respondents said yes. Those who answered in the affirmative were then asked if the ICT policy included each of 11 specific policy components (items a to k of NCQ24). The sum of these components constitutes q24 in Table 3.4. These components were clear vision, support for curriculum innovation, desired mode of integrating ICT in teaching, desired minimum level of access to ICT, desired internet connectivity, goal to reduce digital divide, attempts to ensure ICT access outside of school, teachers' PD requirements on ICT, stimulation of teachers' professional development in ICT, evaluation policy for ICT implementations, and funding arrangements.

The education systems varied considerably with regard to the number and type of ICT-related policies they had in place. Estonia, the Russian Federation, the Slovak Republic, and Slovenia had no policy components whereas Israel and Singapore had all 11. Some systems mentioned other policy components in the "other" category. For example, the NRC for Norway pointed out that Norway now defines digital literacy as a core competency, with the same level of importance as reading, numeracy, and writing.

3. Provision of hardware and software

The questionnaire offered several options (under NCQ25) on how each education system managed hardware and software funding and acquisitions. Respondents were asked to check all options that applied. The options were (a) funds provided through a central facility, (b) funds provided to schools, (c) matching or partial funding provided by a government unit, (d) government funds for internet connectivity, (e) funding is an integral part of the school budget, and (f) no government funding provided. The responses are listed in q25 of Table 3.4. Response alternatives (a) (central facility) and (d) (funds given to schools) were the most commonly selected—nearly half of the respondents chose them. "No government funding" (option f) was chosen by only two systems: the Slovak Republic and South Africa. It seems that funding for hardware and software in the majority of education systems flows from several different government levels.

4. Language as an ICT obstacle

Yes/no answers were solicited in relation to NCQ26, *"Is language an obstacle for schools in ICT-implementation in teaching and learning?"* Eight of the 22 education systems indicated that language was an obstacle; the remainder said no. Not surprisingly, in those education systems where language was considered an obstacle, English is not the primary language spoken at home. Although English is an official language in South Africa, language is still an obstacle, as there are 10 other official languages. Also, because English is the most common language used on the World Wide Web, it is not surprising that the majority of the respondents saw language as a problem.

A comment from the Israeli respondent suggested how policies can address the language barrier:

> The extent to which language is an obstacle for schools in ICT implementation in learning and teaching is dependent on the age of the students: the younger the students—the higher is the obstacle. The main obstacle lies in Internet use, since most websites are in English, which is not a mother tongue in Israel. However, English as a foreign language is a compulsory subject in the middle of primary school (sometimes even from 2nd grade), therefore, by secondary education, students can cope with websites in English. Still, this is an issue that required attention . . . therefore, some steps have been taken to minimize the dependency on English materials, e.g. (1) translation and adaptation of software for Hebrew-speaking children and Arab-speaking children, (2) translation and adaptation of online teaching and learning materials for Hebrew-speaking children and Arab-speaking children, (3) development of a national database for learning objects, led by the ministry of education—sharing of teaching and learning materials via discussion groups and educational portals, (4) nation-wide ICT-based projects facilitated by non-profit organizations.

5. ICT skills at the target grade

The NRCs were asked if their systems had a system-wide program regarding student ICT-related skills at the target grade. The q28 column in Table 3.4 summarizes the answers to that question. Twelve of the respondents said "yes," nine said "no," and one did not respond. Those education systems that had implemented a system-wide program

Table 3.4 ICT factors by education system

Education system	(q20a) Index of increased spending for ICT	(q24) No. of ICT policy aspects	(q25) Provision of hardware, software
Alberta Province, Canada	18	5	de
Catalonia, Spain	24	6	abd
Chile	9	7	abcd
Chinese Taipei	21	6	bd
Denmark	.	3	ce
Estonia	23	11	cd
Finland	22	9	de
France	21	7	bd
Hong Kong SAR	12	6	bcd
Israel	17	11	abd
Italy	28	8	.
Japan	17	3	cd
Lithuania	20	6	a
Moscow, Russian Federation	23	6	a
Norway	25	5	e
Ontario Province, Canada	21	1	e
Russian Federation	21	0	a
Singapore	15	11	abcd
Slovak Republic	19	0	ef
Slovenia	.	0	.
South Africa	19	11	af
Thailand	21	8	a

Notes:

(q20a) Increase in spending for ICT is the sum of a series of seven questions asking if each of ICT-spending had decreased or increased during the past five years (NCQ20, items b to h); scored on 4-point scale of (1) decreased; (2) no change; (3) increased a little; and (4) increased a lot

(q24) No. of ICT policy aspects is the sum of 11 questions (NCQ24) on each of 11 components (items a to k) of ICT-policy.

(q25) Choices to question NCQ25 on how hardware and software are funded and acquired by schools (see main text for options)

involving one or more compulsory classes in ICT included Chinese Taipei, France, Japan, the Slovak Republic, and Thailand. Those that had implemented a program that infused ICT-based instruction throughout several or all other subjects included Alberta Province, Chile, Denmark, Finland, and Singapore.

6. 21st-century skills policy

The SITES 2006 conceptual framework document defined "21st-century skills" in terms of two components—"collaborative inquiry" and

Table 3.4 ICT factors by education system (Continued)

Education system	(q26) Language as an ICT obstacle	(q28) ICT skills at target grade	(q30) 21st-century skills policy
Alberta Province, Canada	no	yes	yes
Catalonia, Spain	no	yes	yes
Chile	no	yes	yes
Chinese Taipei	no	yes	yes
Denmark	no	yes	yes
Estonia	no	yes	no
Finland	no	yes	yes
France	no	yes	no
Hong Kong SAR	no	no	yes
Israel	yes	no	yes
Italy	no	no	no
Japan	no	yes	no
Lithuania	yes	no	no
Moscow, Russian Federation	yes	no	no
Norway	no	no	yes
Ontario Province, Canada	no	no	yes
Russian Federation	yes	no	no
Singapore	no	yes	yes
Slovak Republic	yes	yes	yes
Slovenia	yes	.	.
South Africa	yes	no	yes
Thailand	yes	yes	yes

Notes:

(q26) Yes/No are answer choices to question 26: "Is language an obstacle for schools in ICT-implementation in teaching and learning?"

(q28) ICT-skills at the target grade is the answer to NCQ28 about the presence of "a system-wide program on student ICT-related skills"

(q30) 21st-century skills are the answer to NCQ30 as to presence of any system policy documents that mention the promotion of "21st-century skills".

"connectedness". The last question in the NCQ questionnaire was "*Do any of your educational system's policy documents promote approaches that mention "21st Century skills"* (q30). In response to this question, 14 NRCs said "yes," seven said "no," and one did not respond. Those with policies mentioning 21st-century skills were asked to summarize the country's policy, and these are briefly described in the next sub-section.

3.4 National policies for ICT and pedagogical reform

The NRCs were asked to write a brief description of any 21st-century skills program/policy their country had for the target grade. They were also asked to describe any system-wide ICT-skills program for the target grade and any target-grade initiatives for new pedagogies. The descriptions for any such programs are summarized below in order to provide a profile of national reform trends related to these types of programs.

3.4.1 Alberta, Canada

In 2004, Alberta published its "Learning and Technology Policy Framework." Although the document does not reference 21st-century skills, it does emphasize learning in the knowledge economy and lifelong learning. And while it does not promote constructivism, it does emphasize individualized learning, learning communities, and optimal learning environments. Alberta's policy on ICT-skills is to infuse ICT in learning all subjects.

3.4.2 Catalonia, Spain

Integration of ICT in teaching, learning, and evaluation processes is a priority for Catalonia's school system. The Department of Education has established that schools must foster pedagogical strategies aimed at developing communication skills and building shared knowledge. Another departmental mandate is that secondary education students must develop, across all school subjects and through application of today's wide-ranging palette of digital resources and devices, the information-processing and management skills they need to create text, support oral and distance communication, and work with numbers and figures. Further, use of ICT should include visual-arts production and musical expression, as well as interaction with the physical environment. Catalonia's teachers are asked to play a decisive role in advising and supporting students as they search and evaluate internet content as part of their learning. A key principle is that learner autonomy, ICT-skills, and student values have to be developed in harmony.

3.4.3 Chile

ICT-skills are part of Chile's secondary curriculum. At the time of SITES 2006, the Ministry of Education had begun a pilot project that aimed to provide students with ICT-skills and related course materials based on the International Center for Distance Learning standards. The national curriculum contains several references to 21st-century skills.

3.4.4 Chinese Taipei

Chinese Taipei's newly implemented nine-year joint curriculum (an integration of the previous elementary and junior high curricula) claims to cultivate 21st-century citizens, but the notion of 21st-century skills is not formally defined. The curriculum emphasizes that all learning subjects should integrate ICT into their instructions. It aims to develop students' skills in collecting, analyzing, and utilizing information, as well as their ability to problem-solve and collaborate, to be active learners, and to engage in lifelong learning.

3.4.5 Denmark

Since the late 1990s, the Danish Ministry of Education has published a couple of action plans for integrating ICT in the education system. The plans specify the need to increase student skills in ICT and the need to integrate new pedagogic opportunities into learning. While the plans do not mention 21st-century skills, they do emphasize learning goals and activities very consistent with that movement. In addition to requiring the purchase of computers, the action plans focus on better access to the internet, email, and virtual networks, increased use of ICT in relation to tests and examinations, and increased integration of ICT in the pre- and in-service training of teachers. For further information, see http://eng.uvm.dk/publications/10InformationCom/1.htm?menuid=1535

3.4.6 Estonia

Estonian schools use the national curriculum enacted as a government decree in 2002 and subject to amendments in 2008 or 2009. The curriculum includes four cross-curriculum topics that include ICT and media education. ICT-use and the development of ICT-literacy are together understood as one of the main instruments to enhance work efficiency and social mobility. To implement the program, the Tiger Leap Foundation (TLF) was established in 1997. The intention behind this decision was to separate ICT-based activities from the general functioning of the Ministry of Education, to bring a more dynamic and open process to decision-making, and to guarantee targeted financing for ICT-related needs. During the 10 years of the Tiger Leap program's existence, three strategies were enacted, each with a specific focus developed out of previous achievements and each looking forward to the issues that remain. By 2009, the "Learning Management Systems with Learning Object Repository and Learning Object Brokerage Platform" will be in use. Also, e-learning has been targeted as an initiative to be seamlessly integrated into everyday school life, and with at least 90% of all teachers using ICT in the learning process. For further information, see (1) *Learning Tiger: Strategy 2006–2009* (available from http://www.tiigrihype.ee/?op=body&id=190), and (2) *Tiger Leap 1997–2007*, which covers the work of the Tiger Leap Foundation.

3.4.7 Finland

As is evident from various policy papers, Finland's strategy has been to develop ICT in education as part of the country's aim to build a Finnish information society. Efforts have therefore been put into creating ways of using ICT to meet the diverse needs of people of different ages. The latest strategy paper—*The National Knowledge Society Strategy 2007–2015* (available from http://www.tietoyhteiskuntaohjelma.fi/esittely/en_GB/introduction/)—emphasizes the creation of a culture of learning and working in association with a system of tight-knit collaboration networks that include decision-makers, developers, implementers, and users.

Finland's ICT-skills-related strategic intent for year 2015 is that ICT will be inseparably linked to the daily life of citizens and organizations, and also to the ability of individuals and work communities to renew and continue to develop knowledge and learning, a development that Finland sees as the foundation of its economic and social competitiveness and well-being. The Information Society Program for Education, Training, and Research (2004–2006; http://www.minedu.fi/OPM/Julkaisut/2004/koulutuksen_ja_tutkimuksen_tietoyhteiskuntaohjelma?lang=en&extra_locale=en) contains actions aimed at developing all citizens' information society knowledge and skills, and promoting social innovation through the use of ICT.

Finland's national core curriculum for basic education (2004; http://www.oph.fi/english/) emphasizes that the learning environment and its equipment should support students' development in a manner that recognizes students as members of a modern information society. The core curriculum includes two (out of seven) cross-curricular themes that refer to students' understanding of technology, their ICT-related skills, and their ability to use ICT in a versatile and responsible way.

3.4.8 France

In 2002, the French prime minister presented a new set of goals for a policy on ICT-use at different levels of education. The "2004–2006 Action Plan" called for France to be in the top tier of education systems using ICT in education. In 2006, France established the "IT and Internet Proficiency Certificate." This qualification specifies the ICT-skills development required at all levels of the education system. The emphasis is on subject-specific ICT-related learning activities.

3.4.9 Hong Kong SAR

One of Hong Kong's policy goals is to empower learners with IT: "Students will acquire the necessary skills, knowledge and attitudes for lifelong learning and creative problem solving in the information age" (http://www.edb.gov.hk/index.aspx?nodeid=72&langno=1). Students are to use IT for information retrieval, knowledge enquiry, communication, collaboration, and as an analytical and personal development tool. The 2004 document, *Information Technology in Education: The Way Forward* (see above link), which called for education to move to a learning-centered stance, argues that this approach, in association with internet project-based learning, is a paradigm shift that should be achieved within five years. Activities and resources specific to ICT in education can be found at http://www.edb.gov.hk/index.aspx?nodeid=72&langno=1, while http://www.edb.gov.hk/index.aspx?langno=1&nodeID=2497 provides information on general education matters.

3.4.10 Israel

The fourth and current stage of the Israeli "National Computerization Program" focuses on 21st-century skills and emphasizes ICT as a lever for system-wide change and "ICT as a way of life." This stage includes broad implementation of ICT-based literacy and information skills in learning processes, facilitation of novel concepts and teaching-learning processes in knowledge-saturated learning environments, and spreading ICT-culture typical of the digital age. Current goals emphasize broadening online activities and implementing them in all teaching and learning processes; implementing *standards in information studies;* developing a *bank of learning objects;* fostering *collaborative* learning; and advancing the use of ICT *by populations with special needs*. This national program also advances the implementation of focused programs of various kinds. Examples of these are "Learning without Boundaries" (for Grade 10 students), which encourages students to study literature reflecting local culture in collaboration with peer students abroad; "Ethics and Values on the Web," and "ICT Youth," a youth movement focusing on development of ICT-leadership.

3.4.11 Italy

In Italy, ICT is normally taught in technical and vocational schools (*Istituti tecnici e professionali*). In the mid-1990s, the government of Italy decided to introduce ICT in all schools through a national scheme. This large-scale program, called the "Program for the Development of Educational Technologies 1997–2000" (*Programma di sviluppo delle tecnologie didattiche*) (PSTD), was launched in 1997 by the Ministry of Education and was designed to implement ICT throughout the whole Italian school system. The program was extended to all Italian schools in 1997 and completed in 2000. In 2006, Italy established a national teacher training program on ICT. This initiative, which is a continuation of the so-called "ForTic" program, involves implementation of a national web portal for technological training through a blended-learning modality. The program has three main goals: improving teaching and learning processes; enabling students to master multimedia; and enhancing teachers' professional capabilities by providing them with training in the use and application of ICT. Another aim for the program is to implement new organizational and institutional models across Italy's education system. For further information, go to http://www.pubblica.istruzione.it/innovazione/index.shtml

3.4.12 Japan

Having recognized the necessity of having in place a forward-looking national strategy in regard to the IT revolution, Japan implemented its "e-Japan Strategy" in 2001. The strategy is endeavoring to create a "knowledge-emergent society" that fosters diverse creativity through the exchange of knowledge among citizens. The strategy's vision statement sets education as the main means of realizing the ideal IT society. Accordingly, the strategy calls for all citizens to receive the most advanced level of education regardless of geographical, physical, economic, and other conditions.

Japan maintains that all its citizens need to acquire IT knowledge and skills to enjoy the benefits of these tools, especially in terms of enhancing their intellectual creativity and ability to think logically. Students utilize ICT in all subject lessons taught in school. They are encouraged to bring a proactive approach to learning how to use ICT and to making it part of their learning of subject material. More particularly, their proactive use of ICT is seen as a means of developing high-level communication skills that include ability to collect information, to organize that information, and to express their ideas. Emphasis is also paid to ensuring students learn to adopt moral and appropriate behavior in the virtual world. At the lower secondary school level, students use computers and the internet to learn to communicate with others proactively.

3.4.13 Lithuania

Lithuania has seen a shift in its pedagogical approach from one that emphasizes teaching to one that emphasizes learning. Teacher in-service training programs now stress topics related to collaborative learning, active learning, and the like. The assessment system has not yet adjusted to this shift, so there is some conflict between the new learning goals (e.g., creativity, problem-solving skills) and national standards for assessment. ICT remains largely a separate subject rather than a generalized tool for learning.

3.4.14 Moscow City, Russian Federation

The situation in Moscow reflects the general situation in the country (see 3.4.17 Russian Federation below) However, the city is much more advanced than the rest of the country in the consistency of its regional ICT-policy for education as well as in its financing implementation for this policy. The aim here is to ensure ICT in learning is supported by adequate hardware, software, and connectivity. The regulatory aspect associated with the introduction of ICT into general schools is covered by the concept of the ICT-school. An example of the Moscow approach in this regard is the distance-learning general school for children who cannot visit schools because of their physical conditions (see http://www.home-edu.ru and http://www.liveschool.ru). For further information, visit http://www.school.edu.ru and http://www.intmedia.ru

3.4.15 Norway

The aim of Norway's multi-year "Program for Digital Literacy (2004–2008)" is to smooth out the digital divide (and consequently the social divide) by promoting a vision of digital skills for all. More specifically, the program, which is the government's main effort on ICT in education, addresses the entire education sector. Digital literacy consists of basic ICT-skills, deemed equivalent to reading, writing, and numeracy, and more advanced skills that ensure creative and critical use of digital tools and media, including tasks such as locating and controlling information from different digital sources. In terms of Norway's specific goals for infrastructure, competence, and quality development, the strategy focuses on the use and accessibility of digital learning resources. In the field of research and development, the strategy promotes innovative and pedagogical use of ICT at all levels of the education system.

ICT has also begun to play a major role in assessment in Norway. ICT has been gradually introduced into final examinations in primary and secondary education since 2005, and as of 2008, formative assessment using digital portfolios is being used at all levels of education. More information on these initiatives can be obtained by accessing http://insight.eun.org/ww/en/pub/insight/policy/policy_briefings/countryreport_norway.htm

3.4.16 Ontario, Canada

In Ontario-Canada, students can develop their ICT-skills through an optional course called Information and Communication Technology and Business that is offered in Grade 9. Grade 10 students have access to a course in communications technology. However, ICT-skill development tends to be largely absent from Grade 8.

3.4.17 Russian Federation

Twenty-five years ago, the Soviet Union began its country-wide course titled "Computer Science and Technology," offered during the last two years of high school (i.e., for students ages 16 to 17). The course had two versions—with and without computer support. Today, learning about and with ICT is assumed in primary school, in Grades 8 to 9 (secondary school), and in different profiles of high school.

The Russian Federation's national standards of 2004 require learning with ICT in most school subjects. This learning covers general applications (e.g., text, graphics, and video editing), basic professional and subject-oriented applications (e.g., GIS, CAD, graphical pads, virtual labs, digital sensors, computer control—LEGO-style), and musical keyboards, etc. The practical implementation of the Federation's ICT standards has generally evolved slowly. However, major progress has been made since 2003 via the "E-learning Support Project" (made possible by a World Bank loan to the Russian Federation). Although concentrated on seven regions in different parts of the country, the project is providing digital resources (depository, etc.) for the whole country.

The Federation's unified examinations (combining secondary graduation and university entrance examinations) provide examples of "total" ICT-use (as a communication media). Today, ICT in general schooling belongs to dimensions of the National Priority Projects. So, for example, by the end of 2007, all schools in Russia were expected to have 128K (at least) of connectivity. The new secondary school standards (in development) contain a section on conditions of learning. These include digital information sources and digital instruments (both hardware and software) for learning and teaching. For further information, see http://www.mon.gov.ru, http://www.school.edu.ru

3.4.18 Singapore

In 1997, Singapore launched its "Masterplan for IT in Education" (MPITE). The plan served as a blueprint for integrating information technology in the education system in order to ensure Singaporeans could meet the challenges of the 21st century. The key objective was to use IT to help equip young people with learning skills, creative thinking skills, and communication skills. This was a key strategy for producing a workforce of excellence for the future. Building on MPITE, "Masterplan II for IT in Education" began in 2003.

The use of alternative assessment strategies and open tasks is one of Singapore's more recent efforts to enhance teaching and learning and to use assessment for learning. The mathematics curriculum now emphasizes problem-solving, communication, and making connections, while the science curriculum is moving toward more inquiry-based teaching, learning, and assessment. For further information on the Masterplans, refer to http://www.moe.gov.sg/edumall/mpite/overview/index.html

3.4.19 Slovak Republic

The republic published a policy of school reform called "Millennium" in the year 2000. This initiative was supported by the new government in 2001. Some of the reforms have already been undertaken (e.g., a new law for financing schools), while many steps still remain (e.g., a new school law for primary and secondary education). In the field of ICT in education, the Slovak Republic has, as its policy, supporting the eEurope+ policy.

3.4.20 Slovenia

Slovenia is undertaking a strategy designed to develop an information society in its republic. The strategy, which is based on the strategic frameworks of *i2010*, includes the "National Strategy of e-learning 2006–2010," the goal of which is to develop an efficient and ICT-supported national system of education at all grade levels. The advent of ICT has led to changes in learning processes and subject-matter content in schools; learning is becoming more efficient and attractive, and learning and teaching "whenever and wherever" are now possible, as are virtual classrooms. These plans also emphasize 21st-century skills by offering more self-evaluation and the means whereby students and teachers can develop research skills. For further information on these strategies, see (only in the Slovene language) http://www.mvzt.gov.si/fileadmin/mvzt.gov.si/pageuploads/pdf/informacijska_druzba/Strategija_ si2010.pdf

3.4.21 South Africa

According to South Africa's white paper on e-education,

> The ICT revolution has had an impact on curriculum development and delivery and continues to pose new challenges for education and training systems around the world, which can be summarized into three broad areas, namely: participation in the information society, impact of ICTs on access, cost effectiveness and quality of education, and integration of ICTs into the learning and teaching process. Two new optional school subjects have been introduced: Technology Education, replacing wood-metalwork, and Computer-Applications Technology replacing typing. (Republic of South Africa, 2004, p. 9)

3.4.22 Thailand

In Thailand, limited ICT-infrastructure prohibits the development of many ICT-skills. The learning and teaching of science and mathematics link with project-based learning though the use of ICT-tools, and the internet where applicable. The National Education Act B.E. 2542 (1999) clearly identified the general provisions for the development of 21st-century skills, as driven by technologies for education (Chapter 9). Thailand's ninth "National Economic and Social Development Plan" (2007–2011), focuses on developing the quality of life of the Thai people in the knowledge-based learning society through a "sufficiency economy" philosophy.

The issues associated with implementing and using ICT in education were brought to the fore by the Thai results for IEA's Third International Mathematics and Science Study (TIMSS), the OECD's Programme for International Student Assessment (PISA), and SITES-M1 and SITES-M2. As a consequence, mother language, English, mathematics, and science are now focal areas of improvement. Thailand sees thinking skills, learning process, and technology uses as the vehicles by which the country can improve its students' achievement in these areas in particular and their life skills in general.

3.5 Conclusions

The purpose of this chapter was to profile the education systems that participated in SITES 2006, especially with respect to each system's ICT-related policies and practices. We trust that these descriptive profiles will enrich interpretations of the SITES 2006 data in the remainder of this report, and that these interpretations, in turn, will inform the decisions that teachers and schools make from hereon with respect to ICT and learning pedagogies.

In this descriptive overview, we found a great deal of diversity and variation across the 22 systems. While the lessons to be learned are mainly at the system level and not so much in relation to "clusters" of education systems, it is important to note that many of the systems had, at the time of the study, no active, centralized policy to assure that education in their country is well prepared for teaching and learning in the 21st century. The following three findings illustrate this conclusion:

1. Fifteen of the 22 education systems did not have specific ICT-related requirements for teacher certification,
2. Thirteen of the systems reported no formal requirements for key types of teacher professional development, and
3. Twelve education systems did not have a system-wide program that stimulated new pedagogies.

These findings indicate that progress toward realizing the goals implicit in these statements since the SITES-M1 study conducted in 1998 (Pelgrum & Anderson, 1999) has been slow.

When we looked only at the education systems with both centralized funding and a centralized curriculum (Alberta Province, Catalonia, Chile, and Singapore), we found that these had either an official, system-wide policy or program on ICT-skills or a policy on the development of 21st-century skills, or both. This situation is consistent with the expectation that reform policies and programs are more easily established within a highly centralized system. The situation is a very interesting one because we also found that education systems with low income (GDP per capita) were not more likely than systems with higher incomes to be centralized. Nor were these lower-income systems any more likely than higher income systems to have policies on ICT-skills and 21st-century skills involving the use of ICT.

Other than the ICT-related considerations, the theme that emerges most from the analysis presented in this chapter is that of pedagogical reform. The majority of the NRCs reported that the five years preceding SITES 2006 had seen an increase in the following pedagogies in their education systems: inquiry-based learning, individualized learning, collaborative projects, inter-school collaboration, and international collaboration projects. The answers to both the fixed-choice questions and the open-ended questions revealed inquiry-based pedagogies in particular to have been the focus of reform.

In addition to explicitly naming the trends associated with pedagogical reform, official references to goals or programs related to 21st-century skills implicitly recognize movement toward pedagogical reform. Policy statements on 21st-century skills consistently mention the need for active learning and student-centered learning, as well as the need for training in decision-making and collaborative work. Thus, the outgrowth of trends toward curricula and classroom experiences designed for the learning of 21st-century skills inevitably leads toward even more pedagogical reform.

Chapter Four

School Practices and Conditions for Pedagogy and ICT

Willem PELGRUM

This chapter describes (1) the school conditions that potentially affect the teaching and learning practices of teachers and their use of ICT, and (2) changes in the use of lifelong-learning pedagogical practices in schools between 1998 and 2006, as perceived by school principals. The school conditions are described in terms of six conceptual domains included in the conceptual framework of SITES 2006 (see Chapter 2): vision, ICT-infrastructure, staff development, support, and organization of educational reform initiatives. Indicators for each of these domains are described in the sections that follow.

4.1 Introduction

Chapter 2, which described the conceptual framework for SITES 2006, showed that the issue of pedagogy and ICT can be investigated at different system levels: country, school, and teacher. This chapter focuses on the school level. Two main questions constituted the core of the school-level indicators in SITES 2006:

1. Are important conditions for implementing sustainable change present in schools? (This question is derived from Research Question 3; see Chapter 2.)

N. Law et al. (eds.), Pedagogy and ICT Use in Schools around the World, 67–120.

2. Have indicators of emerging pedagogical practices changed over time? (This question relates to Research Question 1; see Chapter 2).

Those readers interested in design issues regarding the school questionnaires (i.e., the questionnaires that were used, sample sizes, response rates, and "data-flagging" policies) should refer to Chapter 2. Readers should also be aware that the South African sample contained a substantial number of schools that did not have access to ICT (see section 4.2.2). Caution is therefore required when comparing the indicators for South Africa with those of the other education systems that participated in SITES 2006. Almost all schools in these systems had access to ICT.

4.2 Conditions at the school level

The indicators for the five domains listed above are described in the following sections.

4.2.1 Vision

An important lesson from earlier research (e.g., Fullan, 1993) is that sustainable development in relation to pedagogy and ICT requires educational actors at several levels of the education system to co-create a common vision of which goals need to be met in order to structure the school of the future. Quite often, as was shown in SITES-M2 (Kozma, 2003), ICT-related innovations in schools are launched by enthusiastic teachers who, as early adopters, initiate activities that usually start as marginal and, in their nature, extra-curricular. Such initiatives are in many cases not sustainable, as can be inferred from observations recorded during SITES-M2. The study showed, for example, that only 34% of the cases (selected because of their good reputations with regard to implementing ICT-related pedagogical innovations) showed evidence of sustainability. Moreover, sustainability of these initiatives was based on the presence of a supportive school environment, characterized by appropriate administrative support (from the school leadership), a sound infrastructure, and the existence of plans and policies (Owston, 2003).

At the school level, school leadership has an important role in stimulating the creation of a common vision for the school. In order to investigate the characteristics of school leaders with regard to their overall vision for the school and their developmental vision for pedagogy and ICT, I addressed the following questions:

1. What vision with regard to *pedagogy* in general, and to *ICT* in particular, do school leaders promote in their schools? Do these visions differ across education systems and can these differences be interpreted?
2. What measures do leaders take to promote a common vision?

Indicators of the extent to which school leaders (generally the school principals) promoted a particular vision of pedagogy were constructed from an item that asked the leaders to indicate to what extent they agreed or disagreed that the school leadership encouraged teachers to achieve each of 10 goals related to their (the teachers') pedagogical objectives. The results are summarized in Table 4.1, where the 10 goals are partitioned into three groups: lifelong learning, connectedness, and traditional. The indicators for each of these groups have reliabilities that varied from satisfactory to very high.

A first observation from Table 4.1 is that the extent of agreement with the statements about pedagogical vision generally is very high, with almost all means between 3 and 4. With regard to the first question posed at the beginning of this section, the following tentative answers can be given:

- School leaders in general claimed that they promoted visions with regard to traditional, lifelong learning and connectedness-related pedagogical goals. Connectedness attracted somewhat less support than the other two dimensions.
- Support for the three visions differed across education systems. Noteworthy are the relatively high scores on lifelong learning in Chile and Thailand versus the relatively low scores in Denmark, Finland, and Norway.

One of the 10 pedagogical vision items asked principals to indicate their degree of agreement with the statement that they encouraged their teachers to foster the development of "responsible internet behavior." Responses indicated that, in all 22 education systems, a majority of school leaders strongly agreed that they encouraged teachers to prepare students for responsible internet behavior. However, in a number of systems (in particular Israel, South Africa, and the Russian Federation), a substantial number of school leaders (20% or more) did not seem to pay attention to this issue.

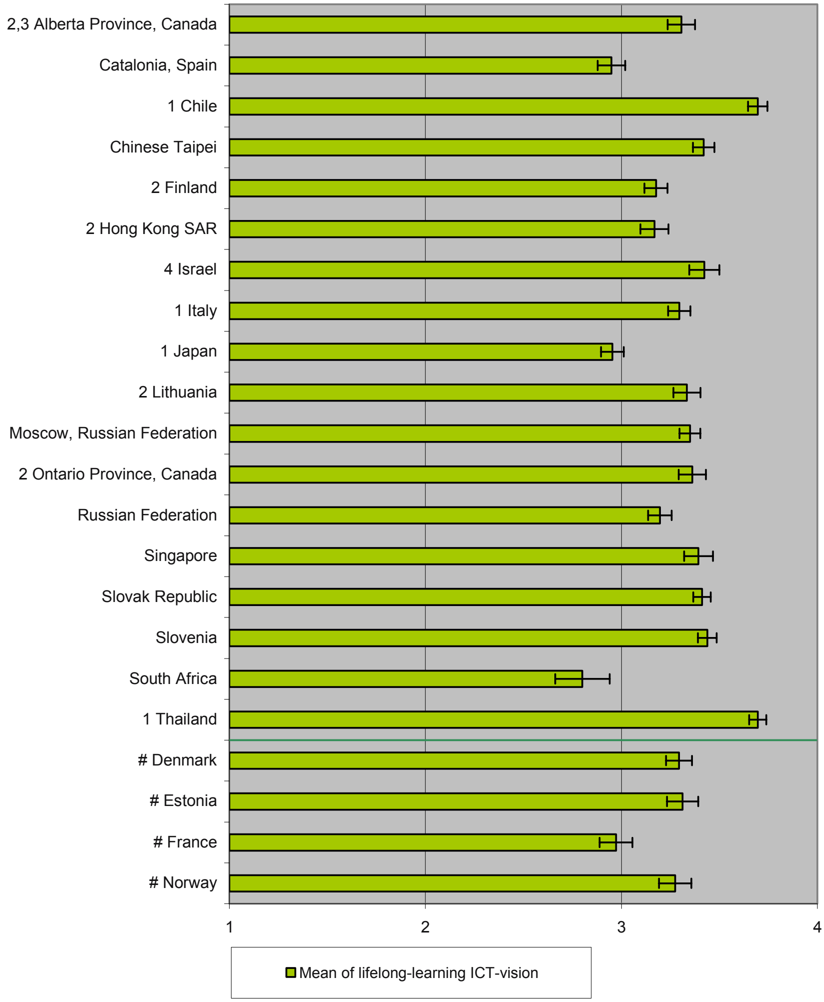
Table 4.1 Vision of school leaders regarding pedagogy (mean (s.e.))

	Education system	Vision lifelong learning	Vision connectedness	Vision traditional
2,3	Alberta Province, Canada	3.35 (0.03)	3.05 (0.04)	3.70 (0.03)
	Catalonia, Spain	3.44 (0.02)	3.27 (0.03)	3.48 (0.03)
1	Chile	3.66 (0.02)	3.29 (0.03)	3.53 (0.02)
	Chinese Taipei	3.45 (0.02)	3.25 (0.03)	3.38 (0.03)
2	Finland	3.07 (0.02)	2.78 (0.03)	3.30 (0.03)
2	Hong Kong SAR	3.29 (0.03)	3.07 (0.04)	3.28 (0.04)
4	Israel	3.27 (0.03)	2.87 (0.05)	3.62 (0.03)
1	Italy	3.55 (0.02)	3.29 (0.03)	3.30 (0.02)
1	Japan	3.28 (0.02)	3.12 (0.02)	3.40 (0.02)
2	Lithuania	3.47 (0.03)	3.08 (0.03)	3.31 (0.04)
	Moscow, Russian Federation	3.47 (0.02)	3.07 (0.03)	3.61 (0.03)
2	Ontario Province, Canada	3.44 (0.03)	3.00 (0.03)	3.56 (0.03)
	Russian Federation	3.36 (0.02)	2.94 (0.03)	3.56 (0.02)
	Singapore	3.52 (0.03)	3.23 (0.04)	3.31 (0.04)
	Slovak Republic	3.33 (0.02)	3.10 (0.02)	3.28 (0.02)
	Slovenia	3.30 (0.02)	3.01 (0.03)	3.30 (0.03)
	South Africa	3.31 (0.03)	3.18 (0.03)	3.60 (0.02)
1	Thailand	3.56 (0.03)	3.37 (0.03)	3.51 (0.03)
#	Denmark	3.21 (0.03)	2.91 (0.04)	3.24 (0.04)
#	Estonia	3.38 (0.03)	2.96 (0.04)	3.37 (0.04)
#	France	3.44 (0.03)	3.09 (0.05)	3.49 (0.04)
#	Norway	3.11 (0.03)	2.62 (0.05)	3.09 (0.04)

Notes:
Value labels for the response categories: 1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree
[#] School participation rate after including replacement schools is below 70%
[1] School participation rate before including replacement schools is below 85%
[2] School participation rate after including replacement schools is below 85%
[3] Less than 70% of the school-level questionnaires in the participating schools were returned
[4] Nationally defined population covers less than 90% of the nationally desired population.

Another item relating to ICT-vision asked school leaders to rate the importance of each of a list of 10 possible uses of ICT in their schools. Only one indicator could be constructed from this item—"lifelong-learning ICT-vision." The scale score (calculated as the mean score across these items) is shown in Figure 4.1. The figure shows that the lifelong-learning indicator was quite high in many systems, although there was variation across countries. Noteworthy are the relatively high scores of Chile and Thailand versus the relatively low scores of Catalonia, France, Japan, and South Africa. How to interpret these differences is not clear

Figure 4.1 Means and confidence intervals for an indicator of lifelong-learning ICT-vision



Notes:

Values for the response categories (importance) were 1=not at all, 2=a little, 3=somewhat, 4=a lot

[#] School participation rate after including replacement schools is below 70%

[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Less than 70% of the school-level questionnaires in the participating schools were returned

[4] Nationally defined population covers less than 90% of the nationally desired population.

and will require further examination of national context information. The Thai NRC made the following observation (slightly edited):

> The National Education Act B.E. 2542 (1999) clearly identified the General Provisions for the development of the 21st skills driven by Technologies for Education (Chapter 9). Also, in the 9th National Economic and Social Development Plan (2007–2011), on the development of the quality of life of the Thai people in the knowledge-based society, ICT is qualified as crucial. Hence, school principals are aware of the importance of ICT.

Five of the 10 statements in this item were not included in the lifelong-learning indicator; the univariates for these are summarized in Table 4.2. From this table, one may infer that, in some systems (e.g., Chile, Thailand), a majority of school principals acknowledged the high importance of ICT for many different pedagogical aspects. However, in some other systems, this opinion was shared by only a minority of school leaders (for instance, those in Catalonia and Japan). Other observations, which call for more in-depth secondary analyses, can also be made from Table 4.2. These include the following:

- In Finland, only 5% of the school principals considered ICT very important for improving the performance of students, whereas in many other countries these percentages were much higher. This outcome may be related to the number of years that schools had been using ICT, but further analysis is necessary to confirm this supposition.
- ICT was recognized as a catalyst for change by a substantial number of school principals in some systems (e.g., Chile, Chinese Taipei, Israel, Lithuania, Slovenia, and Thailand), but this was not the case in other systems (Catalonia, Finland, Japan). When commenting on this observation, the Thai NRC said, "Thailand called for education reform in teaching and learning, student-centered and variety of assessment, so the school leaders encourage teachers to use alternative assessment."
- In some countries (Chile, Thailand), community expectations (by parents particularly) seemed to play an important role in decisions to use ICT but barely so in others (Catalonia, France, Hong Kong SAR).

Table 4.2 Percentages(s) of school leaders indicating that ICT-use is very important for achieving specified pedagogical objectives

Education system	Prepare for work	Improve performance	Exercise skills	Satisfy parents	Catalyst for change
[2,3] Alberta Province, Canada	39 (3.9)	28 (3.7)	30 (3.7)	14 (2.7)	21 (2.8)
Catalonia, Spain	12 (1.9)	14 (2.1)	29 (2.7)	10 (1.8)	11 (1.8)
[1] Chile	58 (2.3)	64 (2.4)	70 (2.5)	64 (2.3)	62 (2.6)
Chinese Taipei	42 (2.4)	26 (2.3)	38 (2.6)	28 (2.3)	47 (3.0)
[2] Finland	47 (3.4)	05 (1.5)	21 (2.5)	17 (2.5)	17 (2.4)
[2] Hong Kong SAR	26 (3.2)	11 (2.4)	16 (2.7)	09 (2.1)	23 (2.7)
[4] Israel	53 (3.2)	43 (2.9)	58 (3.4)	32 (3.1)	46 (2.9)
[1] Italy	29 (2.6)	15 (2.1)	34 (2.5)	24 (2.6)	24 (2.3)
[1] Japan	17 (2.0)	13 (1.9)	10 (1.7)	18 (2.0)	16 (1.8)
[2] Lithuania	33 (3.7)	27 (2.9)	29 (3.4)	39 (3.3)	49 (4.1)
Moscow, Russian Federation	45 (2.8)	34 (2.5)	42 (2.9)	34 (2.6)	42 (2.8)
[2] Ontario Province, Canada	41 (3.1)	26 (2.3)	33 (3.1)	15 (2.0)	24 (2.8)
Russian Federation	35 (2.8)	33 (2.6)	42 (2.8)	29 (2.7)	33 (2.5)
Singapore	44 (4.2)	19 (3.2)	31 (3.4)	14 (2.9)	44 (4.1)
Slovak Republic	55 (2.6)	33 (2.7)	49 (3.1)	36 (2.4)	40 (2.4)
Slovenia	50 (2.7)	29 (2.3)	53 (2.7)	24 (2.1)	60 (3.0)
South Africa	39 (2.5)	38 (2.7)	45 (2.9)	37 (2.7)	38 (2.6)
[1] Thailand	45 (3.0)	58 (2.9)	64 (3.0)	67 (2.8)	77 (2.6)
# Denmark	35 (3.5)	23 (3.0)	32 (3.1)	19 (2.6)	25 (2.8)
# Estonia	50 (4.0)	23 (3.2)	48 (3.4)	40 (3.5)	26 (3.1)
# France	17 (2.5)	29 (3.4)	24 (3.0)	10 (1.8)	24 (2.6)
# Norway	34 (3.8)	28 (3.7)	21 (3.3)	34 (3.9)	31 (3.5)

Notes:

Value labels for the response categories: 1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree

School participation rate after including replacement schools is below 70%

[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Less than 70% of the school-level questionnaires in the participating schools were returned

[4] Nationally defined population covers less than 90% of the nationally desired population.

4.2.2 Infrastructure (hardware and software)

Teachers cannot realize certain pedagogical goals unless information technology equipment and tools are available to them. They need not only sufficient equipment (PCs, printers, internet connections), but also ready access to software tools (for word-processing, communication, information retrieval) and communication facilities (e.g., email addresses for teachers and students). In addition, the location of equipment, ease of access, and maintenance of equipment are potentially important conditions facilitating the use of ICT for teaching and learning. Several questionnaire items related to infrastructure support were addressed to school officials; their responses are summarized in the four sub-sections that follow.

Access

Table 4.3 shows how many schools had ICT—including internet—that students in the target grade could access. The table also shows statistics for systems that participated in the 1998/1999 school year (SITES-M1).

- All but one education system where access was not universal in 1998 could provide students with full access by 2006. The exception was South Africa, despite its enormous leap forward over the eight-year period. The minor differences in the table between 1998 and 2006 of a few percentage points are not statistically meaningful and should not be interpreted as a decline in access.
- In almost all education systems, schools that had access to computers also had access to internet. The main exceptions were the Russian Federation and South Africa, where internet access was still relatively low. Quite substantial increases in access to internet took place in most education systems between 1998 and 2006, in particular in the Russian Federation and Thailand.

The results in Table 4.3 provide one view of access to ICT. However, more detail is needed to determine how much access students actually had to ICT-infrastructure. In Figure 4.2, the number of computers available in a school is expressed as a ratio of the number of students in the school to the number of available computers. This ratio is then expressed in terms of percentages of schools that fell within five categories (fewer than 5 students per computer, 5–9 students per computer, 10–19, 20–40, more than 40). Note that for notational convenience, ratios are reported as single numbers; for example, 5 instead of 5–1.

Table 4.3 Percentages (standard errors) of schools in 1998 and 2006 able to provide Grade 8 students with access to computers and percentages of these schools with access to internet

Education system	Percentage of schools with computers for Grade 8 students (2006)	Percentage of students at schools using ICT for instructional purposes (1998)*	Internet (2006)	Internet (1998*)
[2,3] Alberta Province, Canada	100 (0.0)	-	100 (0.0)	-
Catalonia, Spain	99 (0.5)	-	99 (0.5)	-
[1] Chile	96 (1.0)	-	92 (1.3)	-
Chinese Taipei	100 (0.0)	100	99 (0.7)	62
[2] Finland	100 (0.0)	100	100 (0.0)	96
[2] Hong Kong SAR	98 (0.9)	100	100 (0.5)	80
[4] Israel	96 (1.3)	85	98 (0.8)	53
[1] Italy	99 (0.6)	79	99 (0.4)	73
[1] Japan	99 (0.4)	100	100 (0.3)	58
[2] Lithuania	99 (0.6)	77	100 (0.0)	56
Moscow, Russian Federation	98 (0.7)	-	97 (1.0)	-
[2] Ontario Province, Canada	98 (0.8)	-	99 (0.9)	-
Russian Federation	95 (1.5)	53	49 (3.0)	4
Singapore	100 (0.0)	100	100 (0.0)	100
Slovak Republic	100 (0.4)	-	99 (0.5)	-
Slovenia	99 (0.5)	100	100 (0.0)	85
South Africa	38 (2.3)	18	67 (4.0)	52
[1] Thailand	96 (1.3)	50	97 (1.0)	25
[#] Denmark	99 (0.9)	100	100 (0.0)	85
[#] Estonia	100 (0.0)	-	100 (0.0)	-
[#] France	96 (1.6)	100	98 (1.0)	55
[#] Norway	100 (0.4)	100	100 (0.0)	81

Notes :

* Pelgrum & Anderson (2001); no standard errors provided

- Data not collected

[#] School participation rate after including replacement schools is below 70%

[1] School participation rate before including replacement schools is below 85%

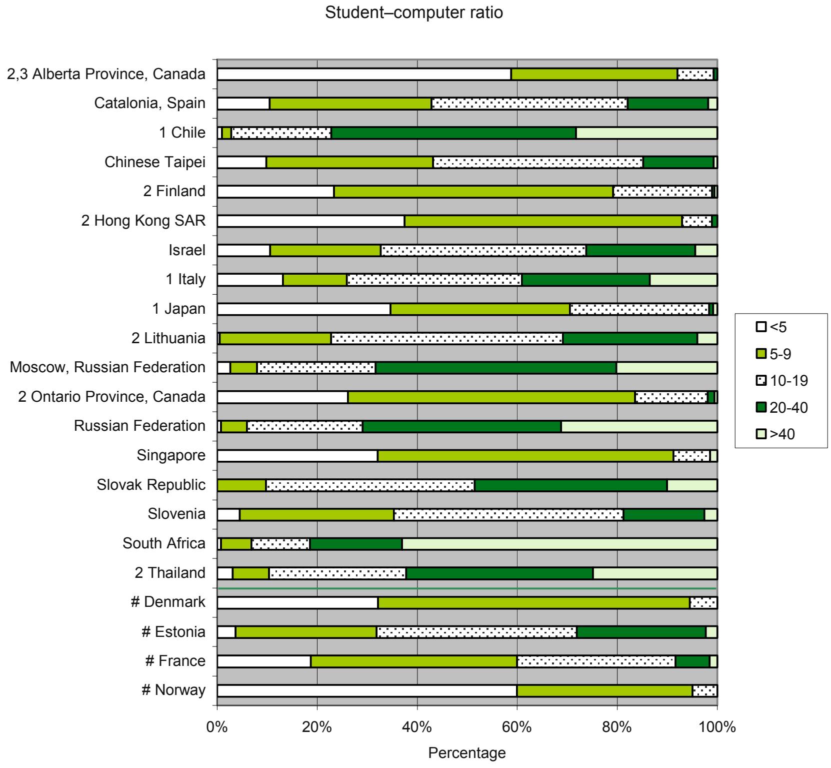
[2] School participation rate after including replacement schools is below 85%

[3] Less than 70% of the school-level questionnaires in the participating schools were returned

[4] Nationally defined population covers less than 90% of the nationally desired population.

Figure 4.2 shows huge differences between education systems in terms of ICT-infrastructural conditions. In some systems, the student–computer ratios were very favorable (fewer than 5) in more than half the schools (e.g., Alberta Province and Norway) or favorable (fewer than 10) (Denmark, Finland, France, Japan, Hong Kong, Ontario, and Singapore). In other systems (in particular, as expected, the developing economies), a favorable ratio had yet to be reached, and in quite a number of systems (Italy, Russian Federation, Slovak Republic, South Africa, and Thailand), hardly any schools had ratios under 10. Huge differences were also apparent within systems, a finding that points to the existence of serious inequities between schools in terms of possibilities for their students to access computers, and one likely to be an important issue for policymakers to consider in forthcoming years.

Figure 4.2 Percentages of schools falling within five student–computer ratio categories



Notes:
*Figure relates only to schools possessing computers
#School participation rate after including replacement schools is below 70%
[1]School participation rate before including replacement schools is below 85%
[2]School participation rate after including replacement schools is below 85%
[3]Less than 70% of the school-level questionnaires in the participating schools were returned
[4]Nationally defined population covers less than 90% of the nationally desired population.

Although Table 4.3 showed that almost all schools in the majority of education systems had access to the internet, this does not necessarily imply that students had *sufficient* access to it. Possibilities for students' access depend on the number of computers in schools that are connected to the internet. Examining the extent to which this was the case required calculation of a so-called student–internet–computer ratio. This ratio was based on the answers of the school technology coordinators to a question asking how many computers in the school were connected to the internet. The resulting indicator (i.e., the number of students in the school divided by the number of computers connected to the internet) showed that most of the computers available in the schools were connected to the internet. Thus, the observations made on the basis of the observed student–computer ratio in Figure 4.2 also held for the student–internet-computer ratio (see Table w4.1 at http://www.sites2006.net/appendix).

The comparison of the access-related information for 1998 and for 2006 showed some significant differences (see Table W4.2 at http://www.sites2006.net/appendix). For example:

- The number of computers in schools increased substantially across the eight-year period in Chinese Taipei, Denmark, Finland, Hong Kong, Japan, Norway, Singapore, and Slovenia;
- In South Africa, more schools had ratios greater than 40 by 2006, but this finding should be seen against the fact that the number of schools possessing any computers increased dramatically from 1998 on.

Computers are not the only ICT-related instruments available in schools. Others, including laptops, PDAs, smart boards, and digital projectors (sometimes called "beamers"), are also used in many jurisdictions. On the basis of earlier assessments, the SITES researchers hypothesized that there would be little evidence of these recently developed devices in schools, but that the availability of these tools would increase in forthcoming years.

For that reason, the SITES researchers deemed it important to report baseline data on the extent to which these tools were available in schools in 2006. The team also considered it important to investigate the availability of graphic calculators, which are generally used in a similar way to particular computer software (e.g., spreadsheets for calculations and programming). A first analysis showed the average number of such devices was close to zero in most systems, except in Hong Kong and Singapore, where, for example, the number of beamers in schools was relatively high (on average respectively 33 and 61 per school).

The distribution of beamers in all systems is shown in Table 4.4 (see Table W4.3 at http://www.sites2006.net/appendix), which contains the distributions for the other devices). Here we can see that the majority of schools in most education systems possessed beamers, but generally no more than five, indicating that this equipment was not yet a standard part of the infrastructure in most classrooms around the world at the time of SITES 2006. Further analyses are needed to determine how much the presence of these devices in classrooms were contributing to the use of particular pedagogical practices in schools (e.g., whole-class teaching).

In the future, it is reasonable to expect that students increasingly will bring their own equipment to schools. As a benchmark for examining these developments, technology coordinators were asked to estimate what percentage of students brought their own PDA, graphic calculator, or laptop to school. In most education systems (see Table W4.4 at http://www.sites2006.net/appendix) in almost all schools, the percentages were below 10%. However, there were some education systems where a sizeable number of schools indicated that students brought their own equipment. For example, more than 10% of the students in about 25% of the Norwegian schools brought their own laptops to school and more than 10% of the students brought their own graphic calculators in a substantial number of schools in Canada-Alberta, Catalonia, Denmark, and France. More than 20% of the students in Moscow brought their own PDAs.

The availability of equipment is one access-related consideration with regard to school ICT-infrastructure. Also important is the question of what tools and facilities teachers and students have available to them to support their teaching and learning activities and what the needs of the schools are with regard to equipment. Table 4.5, which summarizes the data on the availability of a variety of technology applications in the schools, shows that, across the education systems, the following types of applications were available:

- Equipment and hands-on materials (e.g., laboratory equipment, musical instruments, art materials, overhead projectors, slide projectors, electronic calculators)
- Tutorial/exercise software
- General Office suite (e.g., word-processing, database, spreadsheet, presentation software), and

- Multimedia production tools (e.g., media-capture and editing equipment, drawing programs, webpage/multimedia production tools).

Table 4.4 Percentages (standard errors) of schools that possessed a certain quantity of projectors ("beamers") for presentation of digital materials

Education system	0	1	2-5	>5
[2,3] Alberta Province, Canada	4 (1.8)	22 (3.6)	55 (4.6)	19 (2.9)
Catalonia, Spain	7 (1.8)	30 (2.5)	51 (2.4)	11 (1.6)
[1] Chile	42 (2.0)	44 (2.2)	13 (1.3)	1 (0.5)
Chinese Taipei	0 (0.2)	6 (1.4)	51 (2.4)	43 (2.1)
[2] Finland	3 (1.2)	18 (2.0)	59 (2.8)	19 (2.3)
[2] Hong Kong SAR	4 (1.1)	0 (0.0)	2 (0.8)	94 (1.4)
[4] Israel	18 (2.4)	48 (2.8)	32 (2.5)	2 (0.6)
[1] Italy	8 (1.3)	48 (3.0)	43 (2.9)	2 (0.8)
[1] Japan	9 (1.5)	27 (2.1)	57 (2.6)	7 (1.2)
[2] Lithuania	24 (3.1)	34 (3.4)	38 (3.0)	3 (0.9)
Moscow, Russian Federation	18 (2.1)	30 (2.8)	44 (2.4)	8 (1.6)
[2] Ontario Province, Canada	7 (1.8)	51 (3.4)	39 (3.3)	3 (0.9)
Russian Federation	66 (3.0)	25 (2.6)	9 (1.7)	0 (0.1)
Singapore	0 (0.0)	0 (0.0)	0 (0.0)	100 (0.0)
Slovak Republic	36 (2.2)	49 (2.7)	16 (1.6)	0 (0.0)
Slovenia	1 (0.6)	30 (2.3)	66 (2.5)	3 (1.0)
South Africa	79 (1.6)	13 (1.4)	7 (1.0)	2 (0.7)
[1] Thailand	79 (1.5)	13 (1.5)	6 (0.8)	3 (0.5)
[#] Denmark	1 (0.7)	24 (3.2)	66 (3.4)	10 (2.0)
[#] Estonia	10 (2.4)	43 (3.2)	38 (3.8)	9 (2.2)
[#] France	11 (2.8)	23 (2.7)	56 (3.5)	9 (1.7)
[#] Norway	3 (1.4)	16 (3.2)	69 (3.7)	12 (2.4)

Notes :

[#] School participation rate after including replacement schools is below 70%

[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Less than 70% of the school-level questionnaires in the participating schools were returned

[4] Nationally defined population covers less than 90% of the nationally desired population.

Table 4.5 presents a highly variegated picture, but some relatively general trends can be noted.

- ICT-equipment (e.g., laboratory equipment, musical instruments, art materials, overhead projectors, slide projectors, and calculators) was available in more than 75% of the schools. The exceptions were

Chile (47% of schools), Estonia (66%), Israel (70%), Lithuania (72%), Moscow (65%), the Russian Federation (47%), South Africa (17%), and Thailand (40%).

- Tutorial software was available in more than 75% of the schools in Denmark, France, Norway, Ontario, Singapore, and Slovenia. The availability of tutorial software was very low in South Africa (10%) and Thailand (17%).
- General-purpose software (e.g., word-processing, database, spread-sheet, and presentation) was available in most schools in most countries, with the exception of South Africa and Thailand.
- A minority of schools possessed learning management software, such as web-based learning environments. Exceptions were Hong Kong (91% of schools), Norway (70%), and Singapore (95%).
- Mobile devices were evident in very few schools.
- In most education systems, smart boards (interactive white boards) were available in only 20% or less of the schools. The availability was higher in Alberta (47%), Denmark (25%), Hong Kong (26%), Lithuania (32%), Moscow (21%), and Singapore (28%).
- The availability of email accounts was higher in all education systems for teachers than for students (in particular in Alberta, Catalonia, Finland, Italy, Norway, Ontario, and Singapore). The differences between education systems were large. For example, whereas in Alberta, Chinese Taipei, Denmark, Estonia, Finland, Hong Kong, Norway, Ontario, Singapore, and Slovenia, almost all schools had email accounts for their teachers, this was the case in only 18% of the schools in the Russian Federation, 13% of the schools in South Africa, and 11% of the schools in Thailand. Nevertheless, most schools (except South Africa, the Russian Federation and Thailand) possessed communication software.

Needs

While policymakers may be interested in the extent to which equipment is available, they certainly want answers to questions such as “Is the number of PCs available in schools sufficient?”, “Is the available bandwidth for internet use appropriate for realizing the pedagogical goals of schools?”, and “Are there sufficient digital learning resources available in schools?” SITES 2006 provided some data related to these questions through one of the questions asked of technology coordinators. This question asked the coordinators to state which of the resource

Table 4.5 Percentages (standard errors) of schools in which common types of technology applications and facilities were ***available***

Education system	Equipment	Tutorial software	General software	Multimedia production	Data-logging	Simulation	Communi-cation software	Digital resources	Mobile devices	Smart board	LMS	Mail accounts (teachers)	Mail accounts (students)
[2,3] Alberta Province, Canada	88 (3.0)	68 (4.0)	100 (0.0)	81 (3.1)	44 (3.6)	43 (4.0)	76 (3.5)	87 (3.1)	22 (3.4)	47 (4.1)	48 (4.1)	95 (1.5)	53 (4.3)
Catalonia, Spain	88 (1.6)	57 (2.7)	99 (0.7)	84 (2.3)	73 (2.8)	59 (3.0)	89 (1.9)	87 (1.7)	21 (2.1)	07 (1.6)	44 (2.9)	88 (1.9)	49 (2.7)
[1] Chile	47 (1.8)	45 (2.2)	90 (1.3)	54 (2.4)	63 (2.1)	48 (2.2)	79 (1.8)	72 (1.9)	13 (1.5)	06 (1.3)	39 (2.4)	68 (2.0)	52 (2.2)
Chinese Taipei	96 (1.1)	48 (2.5)	99 (0.4)	89 (1.6)	54 (2.5)	21 (2.1)	93 (1.3)	74 (2.5)	10 (1.7)	07 (1.3)	42 (2.8)	95 (1.2)	74 (2.2)
[2] Finland	96 (1.2)	66 (2.8)	99 (0.7)	77 (2.6)	64 (3.2)	20 (2.4)	92 (1.7)	78 (2.6)	11 (2.1)	10 (1.8)	46 (2.7)	97 (1.1)	59 (2.8)
[2] Hong Kong SAR	97 (1.1)	72 (3.0)	100 (0.0)	97 (1.0)	77 (2.7)	47 (3.0)	98 (0.8)	89 (2.0)	20 (2.7)	26 (2.7)	91 (1.8)	98 (1.0)	88 (2.0)
[4] Israel	70 (2.9)	46 (3.3)	96 (1.3)	44 (3.1)	55 (3.6)	16 (2.1)	84 (2.5)	53 (3.1)	13 (1.7)	08 (1.5)	46 (3.0)	54 (3.1)	40 (3.1)
[1] Italy	85 (2.1)	60 (3.2)	99 (0.6)	63 (2.9)	70 (2.6)	37 (2.8)	73 (2.8)	60 (3.1)	11 (2.0)	11 (1.6)	19 (2.2)	64 (2.7)	14 (2.0)
[1] Japan	94 (1.2)	58 (2.5)	97 (0.7)	76 (2.4)	22 (2.1)	39 (2.2)	62 (2.5)	51 (2.4)	03 (0.8)	20 (2.2)	35 (2.4)	56 (2.2)	22 (2.1)
[2] Lithuania	72 (3.1)	74 (2.9)	90 (2.1)	70 (2.9)	70 (3.4)	37 (3.8)	94 (1.5)	87 (2.4)	38 (3.2)	32 (2.9)	19 (2.6)	62 (3.5)	58 (3.6)
Moscow, Russian Federation	65 (2.6)	65 (2.4)	81 (2.1)	47 (2.9)	24 (2.4)	24 (2.4)	81 (2.0)	55 (2.6)	26 (2.3)	21 (1.9)	09 (1.4)	53 (2.5)	38 (2.3)
[2] Ontario Province, Canada	81 (2.5)	78 (2.7)	99 (0.5)	83 (2.4)	75 (3.0)	59 (3.4)	64 (3.2)	90 (1.9)	09 (2.0)	21 (2.3)	54 (3.0)	100 (0.2)	32 (3.1)
Russian Federation	47 (3.9)	61 (3.2)	73 (3.5)	34 (2.7)	10 (1.8)	27 (3.2)	36 (2.7)	49 (3.9)	15 (2.1)	02 (0.5)	05 (1.2)	18 (2.3)	13 (2.1)
Singapore	98 (1.1)	85 (2.9)	100 (0.0)	93 (2.1)	95 (1.8)	66 (4.2)	98 (1.2)	92 (2.2)	34 (3.5)	28 (3.4)	95 (1.8)	100 (0.0)	58 (3.9)
Slovak Republic	75 (2.3)	48 (2.8)	97 (0.9)	68 (2.6)	25 (2.3)	40 (2.9)	97 (1.0)	83 (2.0)	21 (2.0)	17 (2.3)	25 (2.6)	81 (2.0)	72 (2.7)
Slovenia	92 (1.4)	87 (2.0)	100 (0.3)	80 (2.1)	93 (1.3)	55 (2.6)	98 (0.7)	78 (2.1)	21 (2.3)	04 (1.0)	48 (2.5)	97 (1.0)	91 (1.5)
South Africa	17 (1.4)	10 (1.4)	35 (2.2)	07 (1.0)	11 (1.6)	04 (0.8)	14 (1.4)	20 (2.0)	13 (1.8)	09 (1.0)	07 (1.3)	13 (1.4)	08 (1.4)
[1] Thailand	40 (2.4)	17 (2.0)	51 (2.8)	22 (1.9)	04 (1.0)	06 (1.2)	44 (2.4)	49 (2.7)	05 (1.1)	06 (1.2)	13 (1.8)	11 (1.5)	10 (1.3)
[#] Denmark	94 (2.0)	93 (1.9)	99 (1.0)	89 (2.4)	44 (3.7)	53 (3.9)	97 (1.2)	93 (2.0)	11 (2.3)	25 (3.2)	51 (3.7)	96 (1.4)	89 (2.3)
[#] Estonia	66 (3.8)	64 (3.6)	98 (1.1)	57 (4.1)	35 (3.4)	21 (3.4)	93 (2.0)	67 (3.8)	22 (3.2)	21 (2.8)	21 (3.4)	94 (1.8)	57 (4.2)
[#] France	86 (2.5)	80 (3.5)	99 (1.0)	68 (3.3)	76 (3.5)	50 (3.6)	71 (3.3)	83 (2.6)	18 (2.7)	14 (2.6)	26 (3.5)	78 (2.8)	48 (3.7)
[#] Norway	92 (2.4)	88 (2.5)	100 (0.0)	78 (3.2)	28 (3.3)	34 (3.9)	95 (1.3)	83 (3.1)	13 (2.7)	07 (1.8)	70 (4.0)	89 (2.6)	54 (4.5)

Notes:

[#] School participation rate after including replacement schools is below 70%

[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Less than 70% of the school-level questionnaires in the participating schools were returned

[4] Nationally defined population covers less than 90% of the nationally desired population.

materials not available in their schools they would like to have available. These data are presented in Table 4.6. The results in Table 4.6 seem to complement those in Table 4.5 in that "not available" can be translated into "needed." This is a plausible and non-tautological conclusion because respondents could also have responded with "not available and not needed." Further analysis confirmed the existence of this complementary character for smart boards and email accounts for students, but also revealed that it was not fully the case. For example, smart boards were available in only 10% of Finnish schools, but perceived as needed by 46%. Email accounts for students were available in roughly 20% of Japanese schools but perceived as needed in only 19%. Explanations for these responses will require further analyses. In regard to the Japanese email accounts, the NRC for Japan said, "almost all of the Japanese students have their own email account outside school. They have at least one email account in their mobile phone and communicate with their friends very frequently. There are also some cases where schools use the mobile phone's emailing system for communication between school and family."

Another finding based on Table 4.6 data is that, in some systems, schools said they needed many of the listed technology applications. These systems included Chile, South Africa, and Thailand. Also, across systems, it appears that smart boards and learning management systems (LMSs) were seen as needed. In Hong Kong and Singapore, the availability of LMSs seemed sufficient, as only a small percentage of schools (9% and 5% respectively) expressed a need for these tools.

While the questionnaire item that was the data source for Table 4.6 listed equipment and resources to be ticked, the data for another item addressed to school managers throws more light on the highest priorities of schools. Principals were asked to indicate how much priority they attached to resource allocation in several areas, as shown in Box 4.1.

Table 4.7 shows the percentages of principals rating these options as high priority. Quite a scattered picture is revealed in the data, in that sizeable numbers of schools across the education systems had high priorities in most areas. The data also show that the systems had highly individualistic response patterns to these areas of perceived need.

Table 4.6 Percentages (standard errors) of technology coordinators indicating that common types of technology applications and facilities were ***not available but needed***

Education system	Equipment	Tutorial software	General software	Multimedia production	Data-logging	Simulation	Communi-cation software	Digital resources	Mobile devices	Smart board	LMS	Mail accounts (teachers)	Mail accounts (students)
[2,3] Alberta Province, Canada	11 (2.9)	27 (4.1)	0 (0.0)	17 (2.9)	34 (3.9)	42 (3.9)	10 (2.5)	12 (3.0)	15 (2.4)	41 (4.4)	31 (3.9)	5 (1.5)	21 (3.4)
Catalonia, Spain	12 (1.6)	34 (2.6)	1 (0.5)	14 (2.1)	16 (2.5)	31 (2.7)	8 (1.8)	10 (1.7)	38 (2.7)	62 (3.1)	45 (2.8)	8 (1.4)	29 (2.6)
[1] Chile	51 (1.8)	54 (2.2)	9 (1.2)	43 (2.4)	32 (2.1)	49 (2.2)	19 (1.8)	26 (1.9)	57 (2.6)	83 (1.9)	57 (2.4)	27 (2.2)	39 (2.3)
Chinese Taipei	3 (1.0)	45 (2.4)	1 (0.4)	11 (1.6)	35 (2.3)	66 (2.3)	5 (1.2)	25 (2.4)	48 (2.6)	68 (2.6)	54 (2.8)	5 (1.2)	15 (1.9)
[2] Finland	4 (1.2)	31 (2.9)	0 (0.2)	21 (2.4)	22 (2.8)	61 (3.2)	5 (1.4)	20 (2.5)	26 (2.4)	46 (3.6)	38 (2.8)	2 (1.1)	24 (2.6)
[2] Hong Kong SAR	3 (1.0)	23 (2.9)	0 (0.0)	3 (1.0)	13 (2.0)	39 (2.8)	1 (0.7)	9 (1.8)	45 (3.1)	47 (3.1)	9 (1.7)	1 (0.5)	6 (1.3)
[4] Israel	23 (2.8)	39 (2.9)	3 (1.0)	43 (3.3)	29 (3.2)	44 (3.4)	11 (2.0)	36 (3.1)	34 (3.2)	55 (3.4)	42 (2.9)	27 (3.0)	30 (2.8)
[1] Italy	15 (2.1)	36 (2.9)	1 (0.6)	33 (2.7)	22 (2.3)	47 (2.7)	21 (2.6)	36 (2.9)	35 (2.8)	68 (2.5)	61 (2.7)	29 (2.5)	42 (2.5)
[1] Japan	4 (1.1)	24 (2.3)	3 (0.7)	18 (2.1)	36 (2.4)	35 (2.6)	19 (2.0)	31 (2.3)	17 (2.0)	41 (2.5)	26 (2.3)	25 (2.0)	19 (2.1)
[2] Lithuania	27 (3.1)	25 (2.8)	8 (2.0)	27 (3.1)	24 (3.1)	56 (3.5)	5 (1.5)	13 (2.4)	35 (3.2)	64 (3.2)	75 (2.9)	31 (3.0)	29 (2.9)
Moscow, Russian Federation	34 (2.6)	34 (2.4)	18 (2.0)	52 (2.8)	67 (2.5)	74 (2.4)	18 (1.9)	44 (2.6)	59 (2.6)	73 (2.2)	79 (2.0)	42 (2.6)	43 (2.7)
[2] Ontario Province, Canada	18 (2.4)	18 (2.6)	1 (0.5)	14 (2.2)	14 (2.4)	33 (3.2)	13 (2.3)	9 (1.8)	21 (2.5)	53 (3.1)	29 (2.9)	0 (0.2)	20 (2.7)
Russian Federation	52 (3.9)	39 (3.5)	26 (3.6)	63 (2.9)	78 (3.1)	68 (3.0)	63 (2.8)	51 (4.1)	64 (3.1)	92 (1.6)	83 (2.5)	75 (2.6)	74 (2.6)
Singapore	2 (1.1)	10 (2.5)	0 (0.0)	6 (1.9)	2 (1.2)	24 (3.6)	2 (1.2)	6 (1.9)	22 (3.5)	32 (3.9)	5 (1.8)	0 (0.0)	19 (3.0)
Slovak Republic	25 (2.2)	39 (2.4)	2 (0.7)	27 (2.4)	45 (2.9)	51 (3.0)	2 (0.9)	17 (2.0)	41 (2.8)	67 (2.9)	57 (2.8)	12 (1.7)	12 (1.7)
Slovenia	8 (1.4)	13 (2.0)	0 (0.3)	20 (2.1)	7 (1.2)	35 (2.4)	1 (0.6)	22 (2.1)	49 (2.7)	63 (2.8)	45 (2.7)	2 (0.9)	5 (1.2)
South Africa	83 (1.4)	88 (1.5)	54 (2.2)	91 (1.2)	86 (1.7)	93 (1.1)	83 (1.6)	80 (2.0)	79 (2.1)	88 (1.2)	89 (1.3)	83 (1.7)	84 (1.8)
[1] Thailand	59 (2.4)	83 (1.9)	49 (2.8)	78 (1.9)	93 (1.3)	93 (1.4)	56 (2.4)	51 (2.7)	92 (1.5)	91 (1.5)	86 (1.9)	86 (1.7)	87 (1.6)
# Denmark	4 (1.5)	5 (1.8)	1 (0.7)	9 (2.1)	39 (3.6)	35 (3.1)	0 (0.0)	6 (1.9)	34 (3.7)	62 (3.7)	38 (3.8)	2 (1.0)	6 (1.7)
# Estonia	33 (3.8)	36 (3.6)	2 (1.1)	41 (4.2)	48 (3.9)	74 (3.6)	6 (1.8)	32 (3.7)	38 (3.9)	71 (3.3)	72 (3.5)	4 (1.5)	17 (2.9)
# France	14 (2.5)	18 (3.9)	0 (0.0)	26 (3.2)	19 (3.1)	40 (3.7)	14 (2.4)	15 (2.7)	43 (3.8)	70 (3.6)	60 (3.5)	17 (2.6)	31 (3.7)
# Norway	8 (2.4)	11 (2.4)	0 (0.0)	22 (3.2)	56 (3.7)	57 (3.8)	4 (1.0)	16 (2.9)	26 (3.4)	59 (3.4)	25 (3.7)	9 (2.7)	31 (4.1)

Notes:

School participation rate after including replacement schools is below 70%

[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Less than 70% of the school-level questionnaires in the participating schools were returned

[4] Nationally defined population covers less than 90% of the nationally desired population.

Table 4.7 Percentages (standard errors) of school principals giving high priority to a number of infrastructure-related issues

Education system	Decrease student-computer ratio	More computers on internet	Increase bandwith	Increase range digital resources	Online support platform
[2,3] Alberta Province, Canada	28 (3.6)	42 (3.6)	33 (3.1)	29 (3.7)	20 (2.8)
Catalonia, Spain	51 (2.4)	71 (2.5)	55 (2.9)	46 (2.9)	25 (2.3)
[1] Chile	63 (2.3)	84 (1.8)	75 (1.9)	83 (1.8)	56 (2.6)
Chinese Taipei	46 (2.7)	53 (2.7)	64 (2.6)	53 (2.8)	55 (2.8)
[2] Finland	21 (2.8)	29 (2.7)	16 (2.4)	17 (2.7)	18 (2.7)
[2] Hong Kong SAR	24 (3.0)	39 (3.5)	40 (3.7)	30 (3.2)	49 (3.9)
[4] Israel	62 (2.9)	75 (2.6)	55 (2.9)	51 (3.4)	34 (3.3)
[1] Italy	39 (3.1)	49 (3.0)	36 (2.8)	35 (2.6)	22 (2.5)
[1] Japan	36 (2.4)	35 (2.3)	28 (2.1)	11 (1.4)	14 (1.8)
[2] Lithuania	55 (3.3)	66 (3.3)	46 (3.6)	40 (3.5)	26 (3.0)
Moscow, Russian Federation	47 (2.9)	55 (2.6)	42 (2.5)	51 (2.6)	25 (2.5)
[2] Ontario Province, Canada	40 (2.8)	49 (3.0)	23 (2.7)	32 (2.7)	14 (2.0)
Russian Federation	30 (3.2)	27 (2.6)	24 (2.2)	26 (2.9)	11 (1.8)
Singapore	22 (3.6)	50 (4.1)	50 (4.1)	63 (4.2)	79 (3.8)
Slovak Republic	52 (2.6)	67 (2.5)	57 (2.8)	41 (2.6)	24 (2.5)
Slovenia	25 (2.5)	60 (2.7)	32 (2.2)	26 (2.4)	13 (2.0)
South Africa	40 (2.5)	49 (2.5)	40 (2.5)	43 (2.5)	40 (2.4)
[1] Thailand	60 (2.9)	84 (2.1)	76 (2.6)	65 (2.7)	59 (2.9)
[#] Denmark	37 (3.9)	72 (3.8)	45 (3.4)	24 (3.1)	28 (2.9)
[#] Estonia	23 (3.2)	43 (3.6)	32 (3.5)	35 (3.3)	30 (3.4)
[#] France	45 (3.5)	52 (3.7)	34 (3.6)	41 (3.4)	16 (2.5)
[#] Norway	57 (4.2)	62 (3.9)	45 (4.0)	41 (3.7)	52 (4.5)

Notes :

[#] School participation rate after including replacement schools is below 70%

[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Less than 70% of the school-level questionnaires in the participating schools were returned

[4] Nationally defined population covers less than 90% of the nationally desired population.

Box 4.1 Question to school principals about resource priorities

Question:
What priority level do you give to resource allocation in your school in order to enhance the use of ICT in teaching and learning for the Grade 8 students in your school? (answer options: not a priority, low priority, medium priority, high priority)

1. To decrease the number of students per computer
2. To increase the number of computers connected to internet
3. To increase the bandwidth for internet access of the computers connected to internet
4. To increase the range of digital learning resources related to the school curriculum
5. To establish/enhance an online learning support platform and its management so that teaching and learning can take place any time, anywhere

Another perspective regarding the sufficiency of equipment and tools available can be gained from considering the obstacles that schools saw as seriously hindering their capacity to realize their pedagogical goals. School principals as well as technology coordinators were asked to report the extent to which they thought the following infrastructure-related obstacles were hindering realization of their respective school's pedagogical goals: (a) insufficient number of computers connected to the internet; (b) lack of special ICT-equipment for disabled students; (c) insufficient ICT-equipment for instruction; (d) computers out of date; (e) not enough digital educational resources for instruction; (f) lack of ICT-tools for science laboratory work; and (g) insufficient budget for non-ICT-supplies (e.g., paper, pencils).

Table 4.8 contains the percentages of technology coordinators who thought these obstacles were hindering realization of the school's pedagogical goals "a lot." The following observations can be made:

- A majority of respondents in only two education systems saw the obstacles as seriously hindering realization of the school's pedagogical goals. These countries were the Russian Federation (in particular with regard to having insufficient computers connected to internet, insufficient ICT equipment for instruction and a lack of ICT-tools for science laboratory work) and Thailand, where most of the obstacles were perceived as very serious, in particular the lack of ICT-tools for science laboratory work.
- In most education systems, a substantial number of technology coordinators saw lack of ICT-tools for science laboratory work as a serious obstacle. The exceptions were Lithuania and Singapore.

- A noteworthy (but not unexpected) finding was the substantial number of schools in Chile, the Russian Federation, South Africa, and Thailand that complained about insufficient budget for non-ICT-supplies (e.g., paper and pencils). Although the percentages were relatively high in these countries, the corresponding percentages in most other wealthy economies could not be deemed negligible.

Another question of potential relevance for educational policy planning is how many computers in a school need to be connected to internet. A tentative answer to this question can be inferred from an examination of the percentages of technology coordinators who reported that an insufficient number of computers connected to internet formed a serious obstacle to realization of their school's pedagogical goals.

We might assume, on the basis of the results shown in Figure 4.3, that schools with a student–internet-computer ratio lower than 10 would be less likely to complain about insufficient internet connectivity. But such complaints doubtless depend to a considerable extent on other factors, such as the pedagogical approach of the school: a lower ratio might be needed when students have to work independently, while higher ratios might be acceptable in situations where the main pedagogical model is based on working in intact classes.

Figure 4.3 Percentages of technology coordinators who perceived the insufficient number of computers connected to the internet as hindering "to a great extent" realization of their pedagogical goals, broken down by student internet-computer-ratio categories

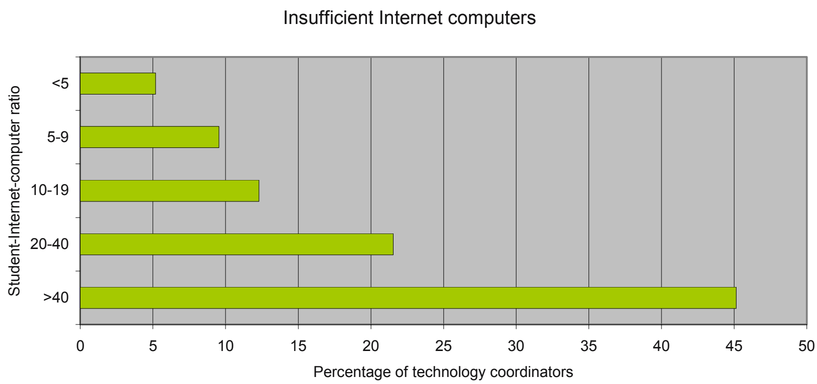


Table 4.8 Percentages (standard errors) of technology coordinators indicating that the school's capacity to realize its pedagogical goals was hindered "a lot" by each of the obstacles listed

Education system	Insufficient computers on internet	Insufficient internet bandwith	Lack ICT for disabled students	Insufficient ICT equipment for instruction	Computers out of date	Not enough digital educational resources for instruction	Lack of ICT tools for science laboratory work	Insufficient budget for non ICT-supplies (e.g., paper, pencils)
[2,3] Alberta Province, Canada	11 (2.9)	6 (2.3)	11 (2.9)	14 (3.4)	18 (3.1)	18 (3.5)	26 (3.8)	18 (3.3)
Catalonia, Spain	8 (1.6)	10 (1.5)	15 (2.1)	20 (2.3)	12 (1.9)	15 (1.9)	16 (2.1)	9 (1.6)
[1] Chile	47 (2.1)	36 (2.0)	23 (2.0)	54 (2.4)	45 (2.4)	48 (2.3)	55 (2.5)	43 (2.6)
Chinese Taipei	5 (1.0)	12 (1.4)	26 (2.2)	18 (1.8)	19 (2.0)	31 (2.4)	46 (2.7)	13 (2.0)
[2] Finland	8 (1.4)	3 (1.0)	3 (1.1)	19 (2.2)	16 (2.2)	25 (2.6)	36 (3.1)	21 (2.6)
[2] Hong Kong SAR	3 (1.1)	5 (1.4)	9 (1.7)	11 (1.9)	38 (3.2)	38 (3.1)	27 (2.8)	9 (1.8)
[4] Israel	29 (2.8)	22 (2.4)	29 (2.5)	43 (2.9)	38 (3.1)	40 (2.7)	42 (3.1)	14 (2.2)
[1] Italy	16 (1.7)	19 (2.2)	20 (2.3)	17 (2.0)	15 (1.9)	21 (2.2)	39 (3.0)	11 (1.8)
[1] Japan	16 (1.8)	24 (2.2)	16 (1.8)	26 (2.1)	27 (2.1)	30 (2.4)	33 (2.4)	16 (1.7)
[2] Lithuania	16 (2.6)	13 (2.2)	4 (1.4)	10 (1.9)	5 (1.5)	7 (1.7)	4 (1.3)	13 (2.3)
Moscow, Russian Federation	39 (2.8)	16 (2.0)	18 (2.2)	50 (2.8)	27 (2.4)	35 (2.6)	51 (2.5)	46 (2.4)
[2] Ontario Province, Canada	17 (2.4)	13 (2.1)	4 (1.3)	26 (2.8)	23 (2.7)	24 (2.8)	47 (3.1)	16 (2.3)
Russian Federation	57 (3.2)	33 (3.0)	20 (2.5)	60 (3.4)	24 (2.4)	47 (4.2)	56 (3.0)	37 (3.4)
Singapore	5 (1.8)	19 (3.2)	4 (1.5)	3 (1.4)	5 (1.8)	20 (3.6)	9 (2.4)	5 (1.8)
Slovak Republic	21 (2.1)	25 (2.4)	31 (2.8)	22 (2.2)	10 (1.6)	35 (2.3)	45 (2.6)	28 (2.4)
Slovenia	10 (1.6)	16 (2.0)	15 (1.8)	28 (2.6)	32 (2.5)	24 (2.4)	46 (2.9)	20 (2.3)
South Africa	53 (2.8)	46 (2.6)	31 (2.6)	50 (2.6)	21 (1.9)	51 (2.7)	57 (2.7)	39 (2.7)
[1] Thailand	68 (2.6)	75 (2.2)	45 (3.0)	72 (2.1)	54 (2.9)	72 (2.3)	77 (2.1)	47 (2.8)
[#] Denmark	10 (2.3)	6 (1.7)	8 (2.1)	12 (1.9)	10 (2.3)	12 (2.3)	47 (3.6)	15 (2.6)
[#] Estonia	13 (2.7)	14 (2.8)	12 (2.7)	27 (3.6)	40 (3.9)	47 (4.0)	51 (4.1)	16 (3.0)
[#] France	15 (2.5)	11 (2.3)	10 (2.0)	21 (3.3)	27 (3.1)	15 (2.7)	28 (3.6)	9 (2.2)
[#] Norway	12 (2.4)	10 (2.4)	9 (2.0)	24 (3.1)	18 (3.3)	25 (3.0)	67 (3.7)	19 (3.6)

Notes :

[#] School participation rate after including replacement schools is below 70%

[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Less than 70% of the school-level questionnaires in the participating schools were returned

[4] Nationally defined population covers less than 90% of the nationally desired population.

Location

Table 4.9 presents information about where computers were located in schools in the participating systems. In the early days of computerization in schools, most schools created dedicated computer rooms, but found this was not an ideal solution for several reasons. Becker and Ravitz (2001), for example, argued that locating computers in or near the classroom had beneficial effects on integrating ICT in teaching and learning. SITES 2006 accordingly asked technology coordinators to indicate where computers were located in their schools. Table 4.9 summarizes their responses, and the following inferences can be drawn from these.

- In most education systems, the schools' computers were located in computer laboratories.
- In regard to schools that had most of their classrooms equipped with one or more computers, only a few education systems (Alberta, Hong Kong, Norway, and Ontario) had at least 50% of their schools equipped in this way. Several other education systems had almost no such schools. They were Catalonia, Chile, France, Israel, Italy, Lithuania, the Russian Federation, the Slovak Republic, South Africa, and Thailand.
- Computers were also available in the libraries of a substantial number of schools in all education systems except Chile, the Slovak Republic, and South Africa. It is not known if the lack of computers in libraries for these last three systems may have been a case of their schools not having libraries.
- Hong Kong stood out as a system where computers seemed to be available throughout the schools.

Maintenance

With the number of computers in schools increasing, maintenance of this equipment is not a trivial issue for schools. In-house solutions (such as appointing ICT-specialists) may be affordable options for large schools, but they are usually beyond the reach of small schools. Table 4.10 shows the data obtained from technology coordinators on maintenance options. More than one source of maintenance support is evident in the table (in those systems where the sum of row-percentages exceeds 100).

Moreover, staff members in a majority of the schools seem to have been involved in maintaining ICT-equipment. In some education systems, a majority of schools were using external companies hired by the school (as in Italy, for example) or arranged by the ministry (as in Israel, the Russian Federation, and Singapore).

*Table 4.9 Percentages (standard errors) of technology coordinators reporting where computers were located in their school**

	Education system	Most classrooms	Some classrooms	Computer laboratories	Library	Other places
2,3	Alberta Province, Canada	51 (4.1)	22 (3.3)	91 (2.6)	75 (4.0)	42 (4.1)
	Catalonia, Spain	1 (0.7)	33 (2.6)	97 (0.9)	56 (2.9)	33 (2.9)
1	Chile	2 (0.7)	3 (0.7)	97 (0.7)	23 (2.1)	10 (1.5)
	Chinese Taipei	20 (2.1)	26 (2.3)	99 (0.7)	53 (2.4)	29 (2.3)
2	Finland	38 (3.3)	46 (3.2)	97 (1.1)	42 (3.0)	23 (2.6)
2	Hong Kong SAR	69 (2.6)	16 (2.4)	99 (0.6)	95 (1.4)	77 (2.8)
4	Israel	1 (0.7)	22 (2.4)	96 (1.4)	55 (3.1)	35 (3.0)
1	Italy	3 (0.8)	14 (1.9)	96 (1.0)	27 (2.4)	35 (2.9)
1	Japan	13 (1.8)	20 (2.2)	99 (0.4)	35 (2.4)	23 (1.9)
2	Lithuania	3 (1.2)	41 (3.1)	78 (3.1)	72 (3.2)	33 (3.5)
	Moscow, Russian Federation	4 (1.0)	52 (2.6)	96 (1.0)	77 (2.1)	36 (2.5)
2	Ontario Province, Canada	62 (3.3)	19 (2.7)	80 (2.5)	73 (2.9)	27 (2.3)
	Russian Federation	0 (0.1)	9 (1.7)	90 (1.6)	36 (2.9)	22 (1.4)
	Singapore	31 (3.7)	17 (3.0)	100 (0.0)	93 (2.0)	63 (3.8)
	Slovak Republic	0 (0.0)	7 (1.0)	98 (0.7)	9 (1.4)	19 (2.1)
	Slovenia	22 (2.3)	55 (2.7)	97 (1.0)	79 (2.1)	28 (2.3)
	South Africa	1 (0.6)	3 (0.9)	48 (2.8)	9 (1.5)	12 (2.1)
1	Thailand	4 (1.1)	17 (1.9)	93 (1.5)	39 (2.3)	43 (3.1)
#	Denmark	14 (2.7)	27 (3.6)	92 (2.0)	84 (2.8)	63 (4.3)
#	Estonia	11 (2.6)	40 (3.6)	98 (1.2)	51 (3.8)	17 (2.8)
#	France	6 (2.1)	70 (3.3)	93 (1.6)	93 (1.4)	40 (3.7)
#	Norway	48 (3.9)	25 (3.5)	84 (3.3)	73 (3.8)	67 (4.0)

Notes:

[*] Only for schools that possessed computers

[#] School participation rate after including replacement schools is below 70%

[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Less than 70% of the school-level questionnaires in the participating schools were returned

[4] Nationally defined population covers less than 90% of the nationally desired population.

Table 4.10 Percentages (standard errors) of technology coordinators indicating the maintenance options available in their schools

	Education system	The school's own staff	Staff from other schools	External hired company	External arranged by ministry
2,3	Alberta Province, Canada	78 (3.6)	10 (2.6)	20 (3.0)	49 (4.4)
	Catalonia, Spain	93 (1.5)	3 (1.0)	33 (2.4)	44 (1.3)
1	Chile	66 (2.2)	3 (0.9)	16 (1.9)	52 (2.2)
	Chinese Taipei	98 (0.8)	6 (1.4)	56 (2.6)	26 (2.5)
2	Finland	68 (2.7)	2 (0.8)	13 (2.2)	12 (2.0)
2	Hong Kong SAR	97 (1.1)	13 (2.3)	59 (3.0)	31 (2.9)
4	Israel	56 (2.9)	1 (0.6)	18 (2.2)	68 (2.6)
1	Italy	74 (2.3)	2 (0.9)	72 (2.6)	1 (0.6)
1	Japan	70 (2.2)	1 (0.4)	27 (2.1)	74 (2.1)
2	Lithuania	89 (2.4)	8 (2.1)	16 (2.6)	10 (2.3)
	Moscow, Russian Federation	74 (2.3)	1 (0.6)	40 (2.6)	61 (2.4)
2	Ontario Province, Canada	79 (2.8)	9 (1.7)	11 (2.0)	52 (3.3)
	Russian Federation	83 (2.1)	5 (1.8)	15 (1.8)	25 (2.9)
	Singapore	49 (3.8)	0 (0.0)	49 (3.9)	87 (2.5)
	Slovak Republic	90 (1.6)	6 (1.3)	30 (2.3)	5 (1.2)
	Slovenia	97 (1.0)	4 (1.0)	49 (2.5)	8 (1.4)
	South Africa	42 (2.4)	2 (0.5)	34 (2.3)	11 (1.6)
1	Thailand	91 (1.7)	15 (2.0)	51 (2.8)	11 (1.8)
#	Denmark	97 (1.2)	9 (2.3)	14 (2.3)	20 (2.9)
#	Estonia	92 (2.0)	1 (0.8)	16 (3.1)	19 (3.2)
#	France	70 (3.0)	21 (2.7)	45 (3.3)	52 (3.2)
#	Norway	92 (2.4)	4 (1.9)	8 (2.2)	60 (4.4)

Notes :
[#] School participation rate after including replacement schools is below 70%
[1] School participation rate before including replacement schools is below 85%
[2] School participation rate after including replacement schools is below 85%
[3] Less than 70% of the school-level questionnaires in the participating schools were returned
[4] Nationally defined population covers less than 90% of the nationally desired population.

4.2.3 Support (technical and pedagogical)

A necessary condition for sustainable integration of ICT is the existence of an adequate technical support structure. SITES Module 2 found that schools use different approaches to realize technical support, and that the existence of ICT-support (technical as well as pedagogical) is necessary for implementing innovations. This section addresses these questions:

1. Who provides ICT-support to teachers and how much time is spent on these activities each week?
2. To what extent is technical support available for teachers who use ICT for new forms of teaching and learning?

With respect to Question 1, Table 4.11 shows the percentages of schools where various categories of personnel were involved in providing ICT-support. The table also shows the amount of time per week that was available per school for this support, expressed as the number of minutes per student. Across the participating systems, quite a number of different categories of persons were involved, including, in almost all schools, a technology coordinator. Other ICT-staff and teachers were frequently involved. Some noteworthy observations are:

- Denmark, Hong Kong, and Singapore had a high rate of other ICT-staff available in addition to the computer coordinator.
- A majority of schools in Hong Kong, Moscow, and Singapore had students providing support.
- External volunteers were barely involved, except in Moscow.
- The number of weekly minutes (expressed as minutes per student for comparability reasons) differed greatly across education systems, varying from two minutes or less (Catalonia, Chinese Taipei, Finland, France, and South Africa) to 10 minutes or more (in Lithuania and the Russian Federation).

For Question 2, technology coordinators were asked to indicate to what extent teachers had technical support available to them when using ICT for each of 11 different activities in which students played an active role. The overall scale had a reliability of 0.92, and the means and confidence intervals of the 11 scale items for each education system are shown in Figure 4.4. The data in the figure indicate that the degree of support available varied quite substantially across the education systems. In Finland, France, Japan, Ontario, the Russian Federation, and South Africa, for example, the score on this indicator was quite low, while in Chile, Hong Kong, Lithuania, Singapore, Slovenia, and Thailand, the score was much higher.

As teachers become more aware that integration of ICT has implications for their pedagogical approaches, and vice versa, the importance of providing pedagogical as well as technical support becomes more obvious to them. This is especially the case when teachers utilize student-centered approaches, as they are generally more likely to

Table 4.11 Percentages of schools where specific categories of persons are involved in providing technical support

Education system	Computer coordinator	Other ICT staff	Other admin. and staff	Teachers	Students	External volunteers	External companies	Others	Hours per week	Minutes per week per student
[2,3] Alberta Province, Canada	89 (2.8)	42 (4.4)	14 (3.2)	72 (3.6)	13 (2.5)	4 (1.6)	12 (2.7)	14 (3.2)	18 (2.3)	3 (0.6)
Catalonia, Spain	93 (1.6)	47 (2.6)	4 (1.1)	64 (2.6)	7 (1.3)	3 (1.1)	27 (2.3)	4 (1.1)	18 (1.3)	2 (0.2)
[1] Chile	88 (1.7)	30 (2.3)	8 (1.2)	71 (2.0)	31 (2.3)	14 (1.7)	14 (1.8)	8 (1.2)	24 (1.7)	5 (0.7)
Chinese Taipei	94 (1.3)	54 (2.4)	3 (1.0)	60 (2.8)	26 (2.1)	5 (1.0)	33 (2.1)	3 (1.0)	26 (1.3)	2 (0.1)
[2] Finland	97 (1.1)	53 (3.0)	8 (1.7)	53 (3.1)	5 (1.5)	1 (0.5)	11 (2.1)	8 (1.7)	10 (0.9)	2 (0.5)
[2] Hong Kong, SAR	96 (1.2)	96 (1.4)	6 (1.7)	71 (3.3)	61 (3.0)	6 (1.5)	21 (2.7)	6 (1.7)	62 (3.0)	4 (0.5)
[4] Israel	93 (1.7)	43 (2.9)	7 (1.7)	54 (3.3)	27 (2.4)	6 (1.4)	30 (2.8)	7 (1.7)	25 (2.0)	4 (0.7)
[1] Italy	92 (1.4)	30 (2.6)	5 (1.2)	71 (2.1)	6 (1.3)	4 (1.2)	10 (1.6)	5 (1.2)	12 (0.8)	3 (0.6)
[1] Japan	80 (2.2)	39 (2.5)	1 (0.6)	50 (2.8)	34 (2.5)	2 (0.6)	8 (1.3)	1 (0.6)	13 (1.0)	3 (0.5)
[2] Lithuania	97 (1.0)	67 (3.3)	13 (2.4)	95 (1.4)	47 (3.4)	9 (2.2)	11 (2.4)	13 (2.4)	39 (2.6)	10 (0.9)
Moscow, Russian Federation	96 (1.0)	62 (2.5)	8 (1.4)	80 (2.0)	51 (2.6)	24 (1.8)	31 (2.2)	8 (1.4)	47 (2.1)	6 (0.7)
[2] Ontario Province, Canada	74 (3.0)	42 (3.2)	5 (1.4)	61 (3.3)	11 (2.3)	4 (1.2)	7 (1.7)	5 (1.4)	10 (1.3)	3 (1.1)
Russian Federation	87 (2.1)	35 (2.7)	8 (1.4)	70 (2.7)	44 (2.7)	12 (1.9)	15 (1.8)	8 (1.4)	27 (2.3)	11 (1.0)
Singapore	95 (1.8)	95 (1.8)	8 (2.4)	77 (3.6)	54 (3.7)	6 (1.9)	57 (4.0)	8 (2.4)	59 (4.7)	3 (0.2)
Slovak Republic	98 (0.7)	51 (2.7)	13 (1.7)	93 (1.5)	20 (2.2)	18 (1.9)	12 (1.7)	13 (1.7)	30 (1.5)	7 (0.5)
Slovenia	94 (1.2)	59 (2.9)	8 (1.5)	78 (2.1)	38 (2.6)	5 (1.2)	22 (2.2)	8 (1.5)	29 (1.4)	6 (0.4)
South Africa	41 (2.3)	24 (2.2)	4 (1.2)	28 (2.3)	14 (1.9)	3 (0.8)	9 (1.6)	4 (1.2)	13 (1.9)	1 (0.4)
[1] Thailand	86 (2.1)	63 (2.7)	9 (1.8)	81 (2.3)	48 (2.8)	5 (1.2)	11 (1.7)	9 (1.8)	25 (1.3)	4 (0.3)
# Denmark	95 (1.7)	72 (3.5)	10 (2.0)	63 (3.9)	4 (1.4)	2 (1.1)	9 (2.1)	10 (2.0)	17 (1.3)	3 (0.4)
# Estonia	99 (0.9)	36 (3.6)	6 (2.0)	76 (3.2)	13 (2.6)	5 (1.8)	9 (2.2)	6 (2.0)	27 (2.2)	6 (0.5)
# France	83 (2.8)	35 (3.6)	3 (1.2)	53 (4.0)	4 (1.8)	2 (1.1)	10 (2.6)	3 (1.2)	11 (1.1)	1 (0.2)
# Norway	100 (0.0)	52 (4.3)	13 (2.6)	74 (3.5)	44 (4.5)	4 (1.8)	16 (2.9)	13 (2.6)	15 (1.5)	4 (0.3)

Notes:

Last column shows available support-minutes per student

School participation rate after including replacement schools is below 70%

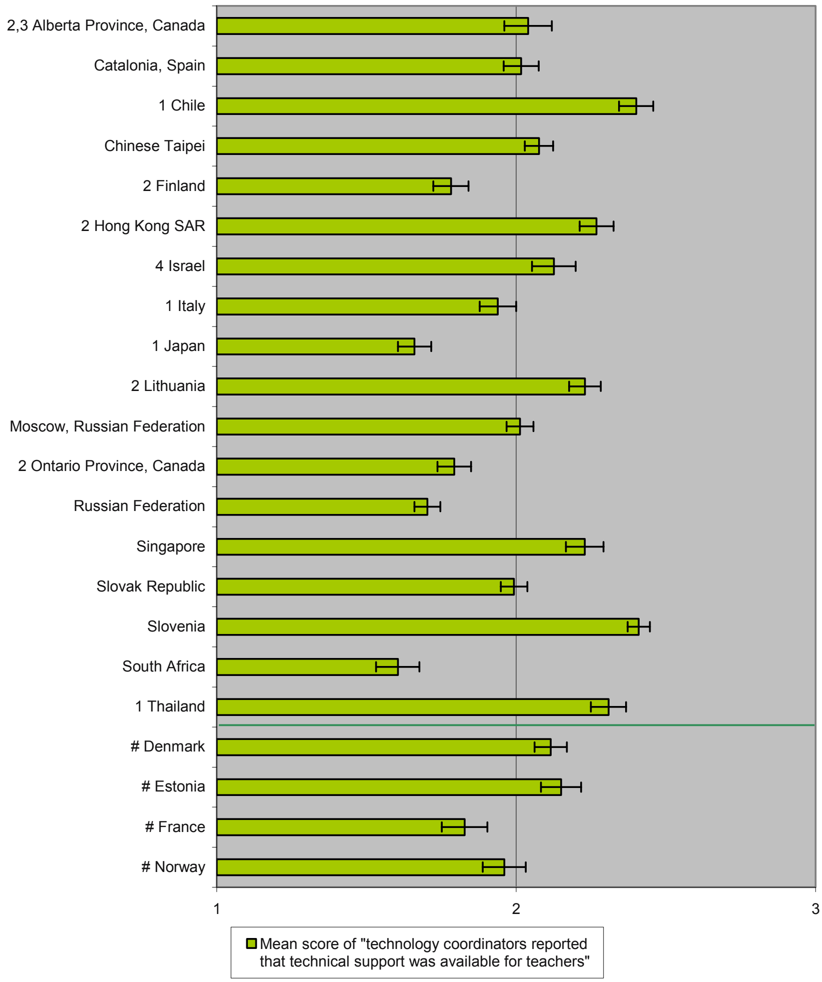
[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Less than 70% of the school-level questionnaires in the participating schools were returned

[4] Nationally defined population covers less than 90% of the nationally desired population.

Figure 4.4 Means (across items) and confidence intervals of the extent to which technology coordinators reported that technical support was available for teachers



Notes:

Values for the response categories: 1=no support, 2=some support, 3=extensive support

#School participation rate after including replacement schools is below 70%

[1]School participation rate before including replacement schools is below 85%

[2]School participation rate after including replacement schools is below 85%

[3]Less than 70% of the school-level questionnaires in the participating schools were returned

[4]Nationally defined population covers less than 90% of the nationally desired population.

be confronted with issues like how to manage activities such as project work, online collaboration, field studies, and so on. An idea of the extent to which pedagogical support was available (1 = not at all, 2 = a little, 3 = somewhat, 4 = a lot) was obtained by asking school principals to indicate the extent to which pedagogical support was available for teachers for each of the following activities: (a) having students produce outcomes related to media production projects (e.g., websites); (b) having students work on short projects (two weeks or less); (c) having students work on extended projects (longer than two weeks); (d) having students collaborate with others by online means, such as online discussion forums; (e) having students conduct open-ended scientific investigations; and (f) having students engage in field-study activities.

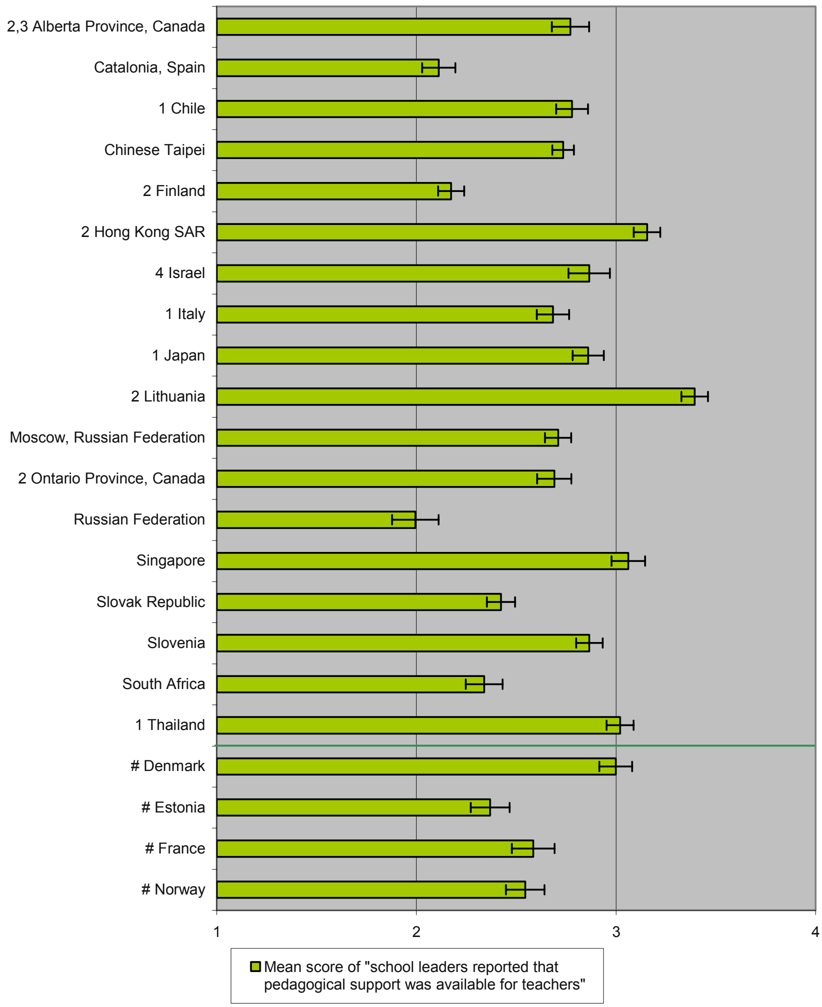
These items were used to construct a composite indicator of pedagogical support (reliability 0.87), for which the means and confidence intervals are shown in Figure 4.5. The availability of pedagogical support for these learning activities was relatively low in Catalonia, Finland, and the Russian Federation, but relatively high in Hong Kong and Lithuania.

The large variation among education systems with regard to the support indicators raises the question of how this situation relates to the experiences of teachers regarding the availability of support (see Chapter 6). Also important to investigate is the question of whether this variation is associated with the people who provide this support, such as experienced colleagues, the school principal, technology coordinators, other school staff, and experts from outside the school (see Table 4.11 above). These questions are of interest for secondary analyses.

4.2.4 Staff development

Because policy directions in school systems tend toward increased use of ICT in schools, the need for staff development programs in this area is bound to increase. According to Jones (2004), teachers lacking confidence and competence can be a major obstacle to effective implementation of ICT. Pelgrum (2001) showed that school principals involved in SITES Module 1 identified this obstacle as a serious one. In SITES 2006, school principals and technology coordinators were asked to what extent they thought each of 15 potential obstacles seriously hindered the capacity of the school to realize its pedagogical goals. As shown in Table 4.12, teachers' lack of ICT-skills did not receive the highest ranking in this list, but about a quarter of all respondents did say that this obstacle hindered the realization of the school's pedagogical goals "a lot."

Figure 4.5 Means (across items) and confidence intervals of the extent to which school leaders reported that pedagogical support was available for teachers



Notes :

Values for the response categories: 1=no support, 2=some support, 3=extensive support

#School participation rate after including replacement schools is below 70%

[1]School participation rate before including replacement schools is below 85%

[2]School participation rate after including replacement schools is below 85%

[3]Less than 70% of the school-level questionnaires in the participating schools were returned

[4]Nationally defined population covers less than 90% of the nationally desired population.

Table 4.12 Average percentages (across education systems) of school principals marking obstacles hindering realization of the school's pedagogical goals "a lot"

Obstacle	%	Obstacle	%
Lack of ICT-tools for science laboratory work	40	Computers are out of date	21
Insufficient ICT-equipment for instruction	31	Insufficient internet bandwidth or speed	21
Not enough digital educational resources for instruction	31	Lack of special ICT-equipment for disabled students	20
Insufficient time for teachers to use ICT	30	Insufficient or inappropriate space to accommodate the school's pedagogical approaches	19
Insufficient qualified technical personnel to support the use of ICT	29	Prescribed curricula are too strict	19
Insufficient number of computers connected to the internet	27	Pressure to score highly on standardized tests	18
Insufficient budget for non-ICT-supplies (e.g., paper, pencils)	25	Using ICT for teaching and/or learning is not a goal of our school	6
Teachers' lack of ICT-skills	23		

Jones (2004) suggested several reasons why teachers lack competence and/or confidence in regard to making ICT part of their pedagogical practice. These include lack of time for training, lack of pedagogical training, and lack of fit between training opportunities and teacher needs. Jones also suggests that this obstacle can be addressed in several ways, including measures that the school leadership might take. The SITES researchers therefore deemed it important to investigate to what extent school leaders were facilitating and stimulating teachers to update their knowledge and skills regarding pedagogy and ICT. Another area examined was the availability of professional development for teachers. SITES 2006 addressed three questions in this area:

1. Are school leaders stimulating, facilitating, or requiring teachers to acquire knowledge and skills to help teachers deal with new pedagogical approaches?
2. What channels are used to deliver training?
3. What training facilities are available to teachers?

With regard to Question 1, school principals were asked whether teachers were encouraged or required to acquire knowledge and skills in the 10 areas shown along the top of Table 4.13. The table shows the percentage of respondents from each education system who indicated whether teachers in their schools were required to have knowledge and skills in each of these areas. In most education systems, hardly any or a small minority of the schools required teachers to be trained in these areas. In Catalonia and in Italy, such requirements barely existed. The percentages were comparatively high in Japan, the Russian Federation, Singapore, South Africa, and Thailand.

With Question 2, respondents were asked which of the 10 ways listed across the top of Table 4.14 their schools were using to help teachers acquire ICT-related knowledge and skills. The table shows the percentage of schools in which each of the options was available. Schools were using a variety of methods to address this issue, but the most common were informal, such as the ICT-coordinator exchanging information with and via colleagues. Staff training conducted by an in-school ICT-committee was less common in all systems except Hong Kong, Singapore, and Thailand. External courses were also quite popular, in particular in Denmark, Lithuania, Moscow, and Singapore, but there was little evidence of them in France.

Respondents were also asked which of seven types of courses were available for teachers and whether these courses were school-based or provided by external agencies. Table 4.15 summarizes the results for this item. It shows the percentage of respondents who indicated, for each course, whether it was available to teachers via in-school and/or external sources. In South Africa, only a relatively small number of schools indicated that such courses were available. Except for introductory courses, this was also the case in Chile. Technical courses for operating and maintaining computer systems were available in 75% or more of the schools in Estonia, the Slovak Republic, and Slovenia. Less than a quarter of the schools in Israel and South Africa reported the availability of these types of courses.

Courses on pedagogical issues related to integrating ICT into teaching and learning were available in more than three-quarters of the schools in Chinese Taipei, Denmark, Estonia, Hong Kong, Lithuania, Moscow, Singapore, and Slovenia. However, there were also quite a few education systems (Alberta, Chile, Finland, Israel, Italy, Japan, France, Norway, South Africa, and Thailand) where sizeable numbers of schools did not seem to have access to such courses. Note, however, that the results in Table 4.15 reflect the perceptions of the respondents, which may have been influenced by a lack of awareness of the existence of particular courses. This surmise is evident in the following comment from Finnish colleagues:

Table 4.13 Percentages (standard errors) of schools requiring acquisition of knowledge and skills in the listed topics

Education system	Integrating web-based learning	Using new ways of assessment	Developing real-life assignments for students	Using real-life assignments developed by others	Using computers for monitoring student progress	Organizing forms of team-teaching	Collaborating with other teachers via ICT	Communicating with parents via ICT	Being knowledgeable about the pedagogical issues of integrating ICT into teaching and learning	Using subject-specific learning software (e.g., tutorials, simulation)
[2,3] Alberta Province, Canada	8 (2.0)	18 (2.9)	10 (2.3)	6 (1.9)	54 (3.9)	12 (2.4)	8 (2.2)	15 (2.8)	26 (3.5)	13 (2.9)
Catalonia, Spain	1 (0.6)	3 (0.9)	6 (1.3)	3 (0.9)	7 (1.5)	6 (1.4)	5 (1.3)	3 (1.1)	9 (1.4)	4 (1.1)
[1] Chile	8 (1.3)	13 (1.8)	26 (2.2)	14 (1.7)	13 (1.8)	23 (2.3)	6 (1.1)	4 (0.9)	11 (1.6)	11 (1.6)
Chinese Taipei	9 (1.7)	15 (2.0)	9 (1.4)	4 (1.0)	5 (1.1)	15 (2.0)	8 (1.3)	3 (1.0)	21 (2.0)	12 (1.6)
[2] Finland	2 (0.8)	2 (0.8)	7 (1.8)	3 (1.2)	8 (1.7)	1 (0.7)	7 (1.7)	11 (2.0)	2 (0.9)	3 (1.1)
[2] Hong Kong SAR	7 (1.8)	7 (1.8)	6 (1.8)	3 (1.2)	5 (1.5)	8 (1.9)	5 (1.5)	4 (1.5)	9 (2.0)	8 (2.0)
[4] Israel	17 (2.5)	23 (2.7)	24 (2.9)	16 (2.3)	24 (2.5)	23 (2.9)	16 (2.3)	7 (1.6)	29 (3.0)	22 (2.6)
[1] Italy	1 (0.7)	15 (2.4)	5 (1.1)	0 (0.0)	2 (0.8)	2 (0.8)	1 (0.6)	0 (0.0)	4 (1.2)	2 (0.7)
[1] Japan	39 (2.2)	35 (2.3)	47 (2.3)	26 (2.2)	31 (2.5)	43 (2.4)	23 (2.0)	9 (1.4)	19 (1.8)	25 (2.1)
[2] Lithuania	7 (1.7)	13 (2.5)	18 (2.9)	15 (2.6)	9 (1.9)	13 (2.5)	16 (2.6)	16 (2.5)	8 (1.9)	15 (2.4)
Moscow, Russian Federation	44 (2.5)	30 (2.3)	31 (2.5)	23 (2.1)	34 (2.2)	32 (2.4)	33 (2.4)	37 (2.3)	39 (2.7)	43 (2.5)
[2] Ontario Province, Canada	7 (1.6)	31 (2.8)	19 (2.4)	8 (1.4)	20 (2.3)	9 (1.8)	10 (1.8)	6 (1.5)	12 (1.8)	10 (1.6)
Russian Federation	60 (3.3)	44 (3.2)	42 (3.1)	28 (3.5)	39 (3.6)	39 (3.2)	44 (3.2)	43 (2.8)	49 (3.4)	47 (2.6)
Singapore	20 (3.2)	28 (3.9)	20 (3.2)	8 (2.4)	38 (4.1)	17 (3.2)	11 (2.7)	15 (2.7)	34 (4.0)	32 (3.9)
Slovak Republic	5 (1.2)	8 (1.4)	20 (2.1)	14 (1.9)	15 (2.0)	10 (1.6)	13 (1.8)	4 (1.0)	15 (1.8)	5 (1.2)
Slovenia	7 (1.3)	7 (1.6)	11 (1.4)	5 (1.2)	10 (1.6)	10 (1.7)	11 (1.9)	2 (0.9)	10 (1.8)	16 (2.1)
South Africa	24 (2.4)	43 (2.1)	31 (2.1)	24 (2.1)	26 (2.6)	28 (2.1)	24 (2.5)	20 (2.5)	25 (2.4)	25 (2.5)
[1] Thailand	44 (2.7)	66 (2.6)	52 (2.6)	39 (3.0)	65 (2.8)	53 (2.9)	56 (2.9)	28 (2.7)	46 (2.9)	42 (2.9)
[#] Denmark	4 (1.3)	20 (2.8)	2 (1.0)	1 (0.7)	5 (1.6)	8 (2.0)	14 (2.1)	10 (2.0)	13 (2.6)	8 (2.0)
[#] Estonia	8 (1.9)	6 (1.8)	25 (3.2)	12 (2.5)	13 (2.4)	8 (2.0)	15 (2.8)	24 (3.5)	21 (2.8)	12 (2.6)
[#] France	2 (1.0)	2 (1.0)	3 (1.1)	1 (0.8)	7 (1.8)	23 (3.1)	4 (1.3)	2 (1.1)	5 (1.5)	3 (1.5)
[#] Norway	6 (2.2)	11 (2.6)	4 (1.6)	0 (0.0)	9 (2.5)	5 (1.6)	14 (2.3)	13 (2.6)	11 (2.5)	2 (0.4)

Notes:
[#] School participation rate after including replacement schools is below 70%
[1] School participation rate before including replacement schools is below 85%
[2] School participation rate after including replacement schools is below 85%
[3] Less than 70% of the school-level questionnaires in the participating schools were returned
[4] Nationally defined population covers less than 90% of the nationally desired population.

Table 4.14 Percentages (standard errors) of schools using particular channels for teachers to acquire knowledge and skills

	Education system	Informal contacts/ communication	ICT coordinator or technical assistant	In-school courses	Training from a teacher who has attended a course	School's working group or committee for ICT in education	Meetings of the teaching staff	Regular newsletter (printed or electronic)	Courses conducted by an external agency or expert (in the school or at distance)	Observation of and discussion with colleagues	Reading professional journals and similar publications
2,3	Alberta Province, Canada	96 (1.7)	86 (2.9)	70 (3.8)	80 (3.2)	59 (4.2)	51 (4.3)	15 (2.9)	56 (4.5)	95 (1.9)	48 (4.2)
	Catalonia, Spain	75 (2.1)	82 (2.2)	80 (2.4)	69 (2.6)	18 (1.8)	24 (2.2)	10 (1.6)	50 (3.0)	75 (2.3)	28 (2.6)
1	Chile	67 (2.1)	76 (1.9)	64 (2.4)	64 (2.4)	21 (1.9)	35 (2.2)	10 (1.5)	43 (2.2)	81 (1.6)	40 (2.4)
	Chinese Taipei	78 (2.1)	76 (2.3)	86 (1.7)	92 (1.3)	44 (2.1)	40 (2.5)	38 (2.7)	57 (2.7)	94 (1.4)	70 (2.2)
2	Finland	87 (2.0)	89 (1.9)	71 (2.8)	62 (3.0)	29 (2.9)	17 (2.3)	10 (1.9)	73 (3.1)	92 (1.7)	70 (3.0)
2	Hong Kong SAR	95 (1.4)	99 (0.6)	94 (1.5)	91 (2.0)	94 (1.5)	51 (3.1)	39 (3.3)	65 (3.0)	91 (1.9)	72 (2.7)
4	Israel	60 (3.0)	75 (2.5)	70 (3.3)	69 (2.7)	23 (2.2)	23 (2.6)	10 (1.8)	47 (3.3)	37 (2.6)	26 (2.7)
1	Italy	66 (2.8)	76 (2.4)	83 (2.2)	63 (2.9)	29 (2.8)	17 (2.0)	3 (1.0)	69 (2.8)	55 (2.7)	41 (2.6)
1	Japan	85 (1.9)	67 (2.2)	58 (2.6)	59 (2.3)	26 (2.2)	19 (2.1)	10 (1.6)	45 (2.6)	91 (1.4)	64 (2.4)
2	Lithuania	69 (3.2)	85 (2.6)	74 (3.2)	90 (2.1)	21 (2.5)	26 (3.2)	38 (3.5)	82 (2.6)	88 (2.4)	74 (3.0)
	Moscow, Russian Federation	92 (1.3)	76 (2.3)	46 (2.6)	59 (2.5)	28 (2.5)	45 (2.6)	34 (2.4)	90 (1.5)	90 (1.6)	70 (2.3)
2	Ontario Province, Canada	94 (1.6)	89 (2.2)	67 (3.5)	83 (2.5)	45 (3.3)	47 (3.1)	28 (2.9)	57 (2.8)	94 (1.4)	48 (3.2)
	Russian Federation	85 (1.5)	48 (3.2)	45 (3.9)	71 (2.5)	19 (2.7)	33 (2.8)	27 (3.0)	72 (3.1)	85 (2.3)	64 (2.5)
	Singapore	96 (1.5)	94 (2.0)	98 (1.2)	91 (2.2)	82 (2.8)	77 (3.1)	36 (3.9)	93 (1.9)	92 (2.2)	56 (4.1)
	Slovak Republic	86 (1.9)	85 (1.8)	74 (2.1)	57 (2.8)	14 (1.5)	26 (2.4)	17 (2.3)	73 (2.5)	53 (2.7)	77 (2.1)
	Slovenia	90 (1.5)	96 (1.1)	87 (1.7)	53 (2.8)	13 (1.9)	27 (2.3)	53 (2.6)	72 (2.4)	93 (1.2)	71 (2.7)
	South Africa	46 (2.4)	26 (2.1)	31 (2.2)	41 (2.7)	15 (1.7)	14 (1.8)	11 (1.9)	32 (2.5)	44 (2.8)	24 (2.5)
1	Thailand	90 (1.8)	70 (2.6)	76 (2.6)	87 (1.6)	67 (2.9)	50 (3.1)	59 (2.6)	74 (2.2)	77 (2.3)	74 (2.5)
#	Denmark	82 (2.7)	93 (1.8)	91 (2.1)	70 (3.2)	50 (3.4)	39 (3.2)	15 (2.7)	80 (2.7)	70 (2.9)	52 (3.6)
#	Estonia	93 (2.1)	93 (2.1)	81 (2.8)	66 (3.7)	20 (2.6)	31 (3.6)	28 (3.6)	79 (3.1)	95 (1.7)	71 (3.5)
#	France	89 (2.3)	78 (3.1)	60 (3.6)	80 (2.7)	14 (2.1)	20 (2.7)	8 (1.8)	16 (2.3)	98 (1.0)	35 (3.8)
#	Norway	95 (1.8)	97 (1.5)	93 (2.2)	71 (3.8)	25 (3.4)	18 (3.0)	17 (3.0)	75 (3.7)	86 (3.3)	50 (4.0)

Notes:

School participation rate after including replacement schools is below 70%

1 School participation rate before including replacement schools is below 85%

2 School participation rate after including replacement schools is below 85%

3 Less than 70% of the school-level questionnaires in the participating schools were returned

4 Nationally defined population covers less than 90% of the nationally desired population.

Table 4.15 Percentages (standard errors) of schools where different types of courses were available for teachers, internally and/or externally

	Education system	Introductory course for internet use and general applications (basic word-processing, spreadsheet, databases, etc.)	Technical course for operating and maintaining computer systems	Advanced course for applications/standard tools (e.g., advanced word-processing, complex relational databases)
2,3	Alberta Province, Canada	85 (2.8)	40 (4.2)	64 (3.9)
	Catalonia, Spain	85 (2.2)	59 (2.7)	76 (2.4)
1	Chile	54 (2.6)	26 (1.9)	26 (1.9)
	Chinese Taipei	85 (1.9)	65 (2.4)	60 (2.3)
2	Finland	68 (3.1)	42 (3.5)	51 (3.1)
2	Hong Kong SAR	90 (1.9)	57 (3.1)	71 (3.0)
4	Israel	62 (3.1)	18 (2.2)	46 (3.4)
1	Italy	72 (2.5)	28 (2.6)	39 (2.8)
1	Japan	65 (2.6)	56 (2.6)	47 (2.8)
2	Lithuania	98 (0.9)	52 (3.8)	84 (2.5)
	Moscow, Russian Federation	92 (1.3)	61 (2.7)	66 (2.4)
2	Ontario Province, Canada	79 (2.7)	40 (3.0)	71 (3.1)
	Russian Federation	77 (2.9)	57 (4.1)	57 (5.0)
	Singapore	86 (3.0)	57 (3.9)	78 (3.4)
	Slovak Republic	97 (0.8)	78 (2.3)	62 (2.8)
	Slovenia	97 (1.0)	76 (2.5)	87 (1.8)
	South Africa	32 (2.3)	19 (2.1)	21 (2.2)
1	Thailand	81 (2.4)	59 (3.0)	38 (2.7)
#	Denmark	87 (2.6)	55 (3.9)	55 (3.7)
#	Estonia	97 (1.4)	79 (3.1)	81 (3.3)
#	France	73 (3.5)	50 (3.5)	51 (3.6)
#	Norway	78 (3.6)	51 (4.0)	40 (4.0)

Notes:
[#] School participation rate after including replacement schools is below 70%
[1] School participation rate before including replacement schools is below 85%
[2] School participation rate after including replacement schools is below 85%
[3] Less than 70% of the school-level questionnaires in the participating schools were returned
[4] Nationally defined population covers less than 90% of the nationally desired population.

> … the availability of external courses is rather good, courses are organized e.g. by Open University, National Board of Education etc. However, teachers are not obliged to participate in PD on ICT use. Thus, usually participants are those teachers who already are interested in the use of ICT. It could also be more a question about whether schools have enough information about the available courses and how actively teachers are encouraged to participate in the courses. And this

Table 4.15 Percentages (standard errors) of schools where different types of courses were available for teachers, internally and/or externally (Continued)

Education system	Advanced course for internet use (e.g., creating websites/developing a home page, advanced use of internet, video conferencing)	Course on pedagogical issues related to integrating ICT into teaching and learning	Subject-specific training with learning software for specific content goals (e.g., tutorials, simulation, etc.)	Course on multimedia use (e.g., digital video and/or audio equipment)
[2,3] Alberta Province, Canada	71 (3.7)	64 (3.8)	69 (4.1)	76 (3.6)
Catalonia, Spain	79 (2.4)	72 (2.8)	60 (2.5)	71 (2.5)
[1] Chile	24 (1.9)	51 (2.1)	32 (2.0)	22 (1.8)
Chinese Taipei	75 (2.4)	91 (1.3)	46 (2.6)	81 (2.0)
[2] Finland	57 (2.9)	47 (3.1)	34 (3.0)	54 (3.4)
[2] Hong Kong SAR	78 (2.6)	77 (2.8)	68 (2.7)	75 (2.8)
[4] Israel	47 (3.6)	57 (3.2)	43 (3.2)	29 (2.7)
[1] Italy	44 (2.6)	44 (2.9)	26 (2.3)	40 (2.8)
[1] Japan	50 (2.5)	40 (2.4)	37 (2.2)	48 (2.4)
[2] Lithuania	86 (2.6)	92 (1.7)	92 (2.0)	82 (2.8)
Moscow, Russian Federation	80 (2.2)	85 (2.0)	90 (1.7)	79 (2.4)
[2] Ontario Province, Canada	73 (2.9)	69 (2.9)	79 (2.7)	76 (2.8)
Russian Federation	58 (4.6)	74 (3.8)	77 (3.8)	59 (4.4)
Singapore	85 (3.0)	83 (2.9)	83 (3.0)	93 (2.2)
Slovak Republic	63 (2.6)	66 (2.5)	58 (2.5)	57 (2.6)
Slovenia	86 (1.9)	79 (2.3)	76 (2.4)	85 (2.0)
South Africa	16 (2.1)	15 (2.0)	17 (2.0)	13 (1.8)
[1] Thailand	67 (2.5)	58 (2.9)	39 (2.8)	33 (2.3)
# Denmark	68 (3.3)	87 (2.5)	87 (2.4)	91 (2.0)
# Estonia	83 (3.1)	88 (2.6)	86 (2.7)	86 (2.9)
# France	58 (3.5)	58 (3.3)	50 (3.6)	66 (3.2)
# Norway	48 (4.2)	65 (3.9)	66 (3.8)	63 (4.1)

Notes :
School participation rate after including replacement schools is below 70%
[1] School participation rate before including replacement schools is below 85%
[2] School participation rate after including replacement schools is below 85%
[3] Less than 70% of the school-level questionnaires in the participating schools were returned
[4] Nationally defined population covers less than 90% of the nationally desired population.

is, again, related to whether schools are active and interested in the use of ICT. This question of information is of course related to the question of access.

4.2.5 *Leadership development priorities*

School leaders need to possess competencies in handling educational innovations in the school. Previous research (BECTA, 2004; McCluskey, 2004) shows that school leaders are change agents, and that their

Table 4.16 Percentages (standard errors) of schools expressing a high priority for training in several areas

	Education system	Developing a common pedagogical vision among teaching staff in the school	Managing the innovation of pedagogical practices in the school	Explaining to teachers the relevance of encouraging students to be responsible for their own learning process and outcomes	Identifying best practices that exist outside the school regarding the integration of ICT in learning	Promoting collaboration between teachers of different subjects
2,3	Alberta Province, Canada	66 (3.8)	45 (3.7)	53 (3.9)	34 (3.6)	58 (4.0)
	Catalonia, Spain	79 (2.2)	61 (2.8)	50 (2.7)	25 (2.5)	58 (2.6)
1	Chile	93 (1.2)	88 (1.7)	93 (1.2)	56 (2.3)	86 (1.6)
	Chinese Taipei	79 (2.2)	62 (2.6)	50 (3.0)	30 (2.5)	29 (2.3)
2	Finland	61 (3.7)	22 (2.5)	55 (3.3)	12 (2.0)	52 (3.4)
2	Hong Kong SAR	45 (3.8)	47 (3.5)	32 (3.5)	9 (1.9)	34 (3.3)
4	Israel	79 (2.3)	62 (3.1)	67 (3.2)	30 (2.7)	51 (3.1)
1	Italy	73 (2.5)	59 (2.8)	74 (2.4)	35 (2.4)	70 (2.5)
1	Japan	65 (2.4)	39 (2.4)	20 (1.9)	4 (1.0)	38 (2.4)
2	Lithuania	58 (3.0)	31 (3.4)	74 (3.4)	17 (2.6)	65 (3.2)
	Moscow, Russian Federation	79 (2.1)	62 (2.5)	82 (2.0)	47 (2.6)	77 (2.0)
2	Ontario Province, Canada	82 (2.2)	61 (2.8)	58 (2.7)	36 (2.6)	65 (2.9)
	Russian Federation	55 (3.5)	46 (3.8)	67 (3.5)	36 (3.6)	58 (3.3)
	Singapore	68 (4.1)	61 (4.0)	65 (4.0)	42 (4.1)	47 (4.5)
	Slovak Republic	51 (2.5)	63 (2.4)	73 (2.2)	29 (2.5)	56 (2.6)
	Slovenia	51 (2.5)	53 (2.7)	66 (2.7)	19 (2.1)	58 (2.8)
	South Africa	78 (2.1)	69 (2.4)	77 (2.3)	46 (2.6)	71 (2.3)
1	Thailand	83 (2.1)	82 (2.2)	81 (2.2)	63 (2.9)	71 (2.5)
#	Denmark	74 (3.1)	64 (3.6)	38 (3.6)	15 (2.5)	53 (3.7)
#	Estonia	85 (2.7)	56 (3.7)	83 (3.1)	28 (3.3)	70 (3.6)
#	France	69 (3.0)	54 (3.6)	51 (3.5)	23 (3.0)	68 (3.5)
#	Norway	68 (3.8)	62 (3.7)	39 (4.4)	18 (3.1)	52 (4.3)

Notes :
[#] School participation rate after including replacement schools is below 70%
[1] School participation rate before including replacement schools is below 85%
[2] School participation rate after including replacement schools is below 85%
[3] Less than 70% of the school-level questionnaires in the participating schools were returned
[4] Nationally defined population covers less than 90% of the nationally desired population.

qualifications in this area are sometimes insufficient. In order to gain an indication of what sort of competencies school leaders need to acquire to manage educational changes effectively, the SITES research team asked the participating school principals to specify the extent to which they thought school leaders needed each of 10 competencies.

Table 4.16 shows the percentages of school principals who saw acquisition of each of these competencies as a high priority. Although the principals in most systems accorded high priority to a good number of the competencies, the principals in Japan gave relatively low rankings.

Table 4.16 Percentages (standard errors) of schools expressing a high priority for training in several areas (Continued)

	Education system	Managing the adoption of ICT-supported methods for assessing student progress	Organizing cooperation with other schools regarding the development of teaching and learning materials	Organizing cooperation with other schools regarding the development of ICT based teaching and learning	Promoting the integration of ICT in the teaching and learning of traditional subjects	Developing a strategic plan for integrating ICT-use in teaching and learning
2,3	Alberta Province, Canada	27 (3.2)	23 (3.2)	16 (2.8)	44 (3.8)	30 (3.4)
	Catalonia, Spain	26 (2.5)	10 (1.6)	11 (1.5)	51 (3.1)	37 (2.7)
1	Chile	56 (2.2)	36 (2.0)	32 (2.4)	71 (2.5)	70 (2.5)
	Chinese Taipei	33 (2.5)	13 (1.7)	16 (1.8)	36 (2.6)	48 (2.6)
2	Finland	15 (2.3)	7 (1.7)	8 (1.8)	19 (2.6)	22 (2.9)
2	Hong Kong SAR	10 (2.1)	4 (1.5)	4 (1.4)	21 (2.9)	23 (3.1)
4	Israel	32 (2.7)	19 (2.0)	14 (2.0)	31 (3.1)	34 (3.1)
1	Italy	22 (2.2)	22 (2.4)	18 (2.3)	45 (2.7)	39 (2.6)
1	Japan	8 (1.4)	7 (1.4)	4 (1.0)	5 (1.2)	5 (1.2)
2	Lithuania	23 (2.9)	24 (3.2)	17 (2.6)	45 (2.9)	32 (3.2)
	Moscow, Russian Federation	54 (2.5)	38 (2.3)	38 (2.3)	65 (2.5)	64 (2.6)
2	Ontario Province, Canada	25 (2.6)	21 (2.4)	11 (1.8)	39 (2.9)	24 (2.3)
	Russian Federation	42 (3.4)	38 (3.0)	37 (3.1)	46 (3.8)	43 (3.9)
	Singapore	32 (3.7)	18 (3.3)	15 (3.3)	48 (4.1)	64 (3.7)
	Slovak Republic	21 (2.5)	11 (1.9)	16 (2.0)	42 (2.9)	30 (2.5)
	Slovenia	8 (1.4)	8 (1.5)	8 (1.6)	17 (2.2)	17 (1.9)
	South Africa	48 (2.8)	56 (2.6)	43 (2.7)	44 (2.6)	48 (2.7)
1	Thailand	66 (2.7)	61 (2.5)	63 (2.5)	74 (2.5)	75 (2.4)
#	Denmark	12 (2.3)	8 (2.0)	9 (2.1)	32 (3.2)	39 (3.8)
#	Estonia	22 (3.1)	17 (2.8)	17 (2.7)	39 (3.8)	46 (3.9)
#	France	31 (2.9)	10 (2.1)	11 (2.1)	42 (3.3)	30 (3.0)
#	Norway	13 (2.8)	13 (2.5)	16 (2.9)	27 (3.8)	35 (4.1)

Notes :
[#] School participation rate after including replacement schools is below 70%
[1] School participation rate before including replacement schools is below 85%
[2] School participation rate after including replacement schools is below 85%
[3] Less than 70% of the school-level questionnaires in the participating schools were returned
[4] Nationally defined population covers less than 90% of the nationally desired population.

Overall, substantial numbers of principals across the systems thought it highly necessary for school leaders to acquire competency in developing a common pedagogical vision among their teaching staff. However, beyond this finding, the differences between education systems in terms of the other competencies are quite striking. For instance:

- In Chile, nearly 90% of the school leaders expressed a need for training with regard to managing innovation, whereas this was the case in about one third of the schools in Japan and Lithuania.

- Explaining to teachers the relevance of encouraging students to be responsible for their own learning processes and outcomes was seen as a high training priority for 93% of the schools in Chile, but only 20% of the schools in Japan. This finding may be a product of the two systems' reform-oriented pedagogical vision for school management, which, as reported in Table 4.2, was relatively high in Chile and low in Japan.
- Most education systems deemed "Managing the adoption of ICT-supported methods for assessing student progress" a low-priority area, even though previous research (Voogt & Pelgrum, 2003) has shown this is a challenging one for educational practitioners.
- Similarly, most of the systems did not accord high priority to "Identifying best practices that exist outside the school regarding the integration of ICT in learning."

4.2.6 Organization and management

When ICT is introduced in schools, a number of organizational and management issues must be considered, solutions to potential problems found, and appropriate actions undertaken. The kinds of issues that may arise include, for example, health risks for students who spend too much time working at computers; "hacking" or unauthorized system access; students spending too much time playing games on school computers; regulating access to computers; and preventing access to adult-only web sites.

School principals were asked to indicate which of 12 possible actions (listed along the top row of Table 4.17) they had undertaken to address these kinds of issues. The cells of Table 4.17 contain the percentages of school principals who indicated that they had taken these actions. Principals in most countries said they had set up security measures, allowed students to use school computers outside of school hours, limited game playing, and specified skills that students were expected to acquire. Measures restricting the number of hours that students could use the computers appeared to be most prevalent in the Russian Federation and Thailand, but of little consequence in Denmark and Hong Kong. Many schools in Chinese Taipei, Hong Kong, and Singapore took measures to provide laptops for teachers. In most schools in Hong Kong, this was also the case with regard to students.

Principals were also asked to indicate the kinds of organizational measures their schools had undertaken to facilitate change and renewal.

They were shown a set of 11 possible measures (listed in the top row of Table 4.18) and asked to indicate which of them they had used. Re-allocating workload to allow for collaborative planning took place in 80% or more of the schools in Chile, Norway, Singapore, and Thailand, but this practice was much less frequently employed in Estonia (43%), Finland (47%), and France (30%). Reviewing the pedagogical approaches used by teachers occurred in most schools in most countries, but not in Finland. Chinese Taipei, Moscow, Norway, and Thailand had all implemented incentive schemes to encourage teachers to use ICT in their lessons, but Finland, Japan, and Slovenia had rarely done so. Many schools in Hong Kong involved parents in ICT-related activities, but France and Japan seemed disinclined to do this.

Principals were additionally asked to indicate how frequently they attempted to stimulate communication about teaching and learning within their own school as well as with members of the wider community. They were presented with a list of 13 possibilities (shown in the top row of Table 4.19) and asked to indicate how often they undertook each such action (answer options were not at all, a few times in the school year, monthly or weekly). The results showed large differences among education systems with respect to management of change. For instance, in Finland and Hong Kong, these actions were rarely undertaken on a regular basis, but in Chile, Ontario, and the Slovak Republic, quite a number of these actions seemed to occur regularly in many schools.

The topics in the last four columns of Table 4.19 focus on cooperation among teachers. It appears that school leaders in a large majority of schools across the education systems encouraged co-teaching, as well as cooperation with colleagues from other schools. Encouragement of cooperation with colleagues from other schools occurs less frequently in Denmark and Israel. School leaders in Estonia and the Slovak Republic seemed not to favor co-teaching. The results also show that school leaders encouraged teachers to discuss professional problems with their colleagues, while in some education systems (notably Catalonia, Chinese Taipei, France, Italy, Japan, and Thailand), school leaders encouraged international cooperation. This latter practice rarely occurred in other systems (e.g., Alberta, Israel, Norway, and Ontario).

Table 4.17 Percentages (s.e.) of schools that had taken particular measures relating to management/organizational issues

Education system	Security measures	Restricting hours student use	Access outside school hours	Access outside class hours	Honoring intellectual property	Prohibitng access adult-only	Restricting game playing	Specifying computer-related knowledge	Community access	Complementing printed materials with digital	Provide laptops to teachers	Provide laptops to students
[2,3] Alberta Province, Canada	98 (1.2)	43 (3.9)	50 (3.9)	94 (1.8)	96 (1.6)	100 (0.3)	88 (2.6)	91 (2.2)	31 (3.3)	92 (1.9)	40 (3.6)	26 (3.5)
Catalonia, Spain	91 (1.6)	63 (2.8)	39 (2.7)	57 (3.0)	81 (2.6)	91 (1.7)	91 (1.7)	87 (1.9)	40 (2.8)	82 (2.3)	42 (2.7)	7 (1.5)
[1] Chile	93 (1.3)	55 (2.2)	77 (2.1)	83 (1.7)	87 (1.7)	98 (0.7)	90 (1.6)	89 (1.5)	71 (2.3)	92 (1.3)	29 (1.9)	19 (1.6)
Chinese Taipei	96 (1.1)	51 (2.5)	44 (2.9)	68 (2.5)	99 (0.6)	99 (0.7)	83 (1.9)	87 (1.8)	37 (3.0)	97 (0.9)	86 (1.9)	25 (2.0)
[2] Finland	96 (1.1)	66 (3.2)	18 (2.3)	61 (3.2)	100 (0.3)	78 (2.4)	94 (1.5)	74 (3.0)	22 (2.5)	83 (2.7)	46 (3.3)	12 (2.2)
[2] Hong Kong SAR	97 (1.0)	21 (2.8)	98 (1.0)	94 (1.7)	100 (0.5)	97 (1.2)	81 (2.7)	86 (2.6)	62 (3.7)	93 (1.8)	95 (1.5)	83 (2.4)
[4] Israel	80 (2.4)	70 (2.5)	50 (3.0)	64 (2.9)	87 (2.3)	93 (1.7)	82 (2.2)	85 (2.4)	36 (2.7)	58 (3.0)	12 (1.8)	8 (1.5)
[1] Italy	90 (2.0)	76 (2.5)	18 (2.2)	46 (2.7)	95 (1.2)	100 (0.2)	99 (0.5)	87 (1.7)	37 (2.9)	86 (2.0)	44 (3.1)	18 (2.3)
[1] Japan	99 (0.4)	59 (2.5)	60 (2.4)	62 (2.4)	97 (0.8)	97 (0.8)	85 (1.8)	78 (2.0)	31 (2.4)	58 (2.4)	44 (2.7)	24 (2.3)
[2] Lithuania	81 (2.8)	69 (3.5)	68 (3.6)	97 (1.2)	88 (2.4)	88 (2.2)	37 (3.1)	72 (3.4)	82 (2.6)	88 (2.1)	51 (3.4)	15 (2.2)
Moscow, Russian Federation	84 (1.6)	90 (1.4)	86 (1.8)	82 (1.8)	92 (1.4)	97 (0.9)	90 (1.7)	97 (1.0)	14 (1.7)	87 (1.8)	40 (2.4)	27 (2.2)
[2] Ontario Province, Canada	97 (0.9)	56 (3.2)	31 (3.0)	85 (2.2)	97 (0.9)	99 (0.7)	90 (1.8)	85 (2.2)	16 (2.2)	83 (2.4)	29 (2.8)	30 (2.9)
Russian Federation	68 (3.0)	79 (2.9)	78 (2.7)	78 (2.0)	82 (2.6)	94 (1.3)	77 (3.0)	91 (1.5)	26 (3.4)	79 (2.9)	23 (3.1)	15 (2.0)
Singapore	98 (1.2)	46 (3.9)	85 (3.1)	92 (2.2)	100 (0.0)	99 (1.0)	88 (2.6)	79 (3.4)	34 (4.0)	97 (1.4)	100 (0.0)	53 (4.2)
Slovak Republic	88 (1.7)	64 (2.4)	58 (2.6)	90 (1.6)	98 (0.8)	95 (1.3)	85 (2.0)	80 (2.1)	71 (2.5)	80 (2.3)	46 (2.6)	11 (1.7)
Slovenia	96 (1.1)	38 (3.0)	81 (2.0)	86 (2.1)	99 (0.6)	99 (0.5)	83 (2.2)	56 (3.0)	48 (2.9)	88 (1.7)	54 (2.8)	13 (1.9)
South Africa	54 (2.5)	37 (2.5)	22 (1.9)	31 (2.4)	49 (2.6)	51 (2.5)	44 (2.6)	47 (2.6)	21 (1.9)	40 (2.5)	11 (1.4)	7 (1.2)
[1] Thailand	49 (2.7)	90 (1.6)	66 (2.6)	93 (1.6)	86 (1.8)	96 (1.2)	93 (1.6)	91 (1.8)	59 (2.8)	81 (2.2)	37 (2.8)	15 (2.2)
[#] Denmark	89 (2.3)	17 (2.3)	48 (3.7)	91 (2.2)	93 (1.7)	63 (3.9)	73 (3.3)	81 (2.9)	24 (3.1)	92 (1.9)	31 (3.5)	44 (3.8)
[#] Estonia	79 (3.2)	69 (3.4)	80 (3.2)	97 (1.2)	97 (1.2)	88 (2.4)	86 (2.2)	85 (2.5)	34 (3.3)	82 (2.7)	44 (3.8)	3 (1.4)
[#] France	92 (1.8)	39 (3.5)	29 (3.3)	82 (2.8)	96 (1.4)	99 (0.5)	96 (1.4)	85 (2.3)	22 (3.5)	60 (3.3)	50 (3.2)	12 (2.5)
[#] Norway	93 (2.3)	26 (3.6)	36 (3.8)	64 (3.7)	88 (2.6)	94 (1.9)	81 (3.0)	76 (3.9)	27 (3.7)	75 (3.5)	60 (4.0)	40 (4.0)

Notes:

[#] School participation rate after including replacement schools is below 70%

[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Less than 70% of the school-level questionnaires in the participating schools were returned

[4] Nationally defined population covers less than 90% of the nationally desired population.

Table 4.18 Percentages (standard errors) of schools that had taken particular organizational actions

Education system	Re-allocate workload for collaborative planning	Re-allocate workload for technical support	Organizing demo-workshops	Review pedagogical approach of teachers	Monitor implementation of change	New teacher teams	Change class schedules	Incentive schemes	Teachers collaborate with external experts	New instructional methods in school newspaper	Parents involved in ICT-related activities
[2,3] Alberta Province, Canada	71 (3.5)	59 (3.5)	83 (2.6)	83 (3.0)	81 (3.3)	63 (3.7)	56 (4.4)	30 (3.3)	87 (3.1)	53 (4.2)	40 (4.0)
Catalonia, Spain	58 (2.6)	67 (2.6)	62 (2.6)	76 (2.3)	68 (2.8)	36 (2.7)	49 (3.1)	11 (1.7)	65 (2.7)	50 (3.2)	33 (2.6)
[1] Chile	81 (2.0)	79 (2.0)	75 (2.0)	94 (1.3)	88 (1.8)	60 (2.3)	61 (2.5)	32 (2.1)	72 (1.9)	53 (2.4)	57 (2.5)
Chinese Taipei	76 (2.2)	76 (2.3)	92 (1.6)	86 (1.7)	82 (2.3)	75 (2.5)	68 (2.4)	67 (2.4)	88 (1.7)	73 (2.3)	58 (2.6)
[2] Finland	47 (3.0)	50 (3.1)	38 (2.9)	52 (3.2)	43 (3.3)	30 (2.5)	45 (3.1)	9 (1.7)	68 (3.5)	23 (2.7)	23 (3.1)
[2] Hong Kong SAR	78 (2.9)	70 (3.4)	93 (1.9)	92 (1.7)	96 (1.3)	75 (3.0)	62 (3.3)	24 (3.0)	84 (2.5)	41 (3.4)	87 (2.2)
[4] Israel	57 (2.6)	58 (3.0)	74 (2.8)	91 (1.7)	82 (2.5)	72 (2.6)	62 (3.3)	30 (2.4)	77 (3.0)	51 (3.0)	37 (3.0)
[1] Italy	61 (2.7)	59 (2.8)	58 (2.9)	74 (2.7)	67 (2.7)	65 (3.1)	44 (2.7)	43 (2.7)	80 (2.3)	41 (3.1)	30 (2.5)
[1] Japan	45 (2.5)	33 (2.5)	27 (2.2)	69 (2.3)	47 (2.4)	19 (2.0)	25 (2.2)	0 (0.3)	40 (2.7)	25 (2.2)	6 (1.1)
[2] Lithuania	56 (3.7)	47 (3.1)	87 (2.7)	83 (2.6)	85 (2.5)	56 (3.8)	35 (3.6)	33 (3.7)	86 (2.7)	54 (3.4)	43 (3.7)
Moscow, Russian Federation	78 (2.1)	76 (2.5)	77 (2.1)	98 (0.7)	89 (1.7)	69 (2.4)	72 (2.4)	73 (2.3)	88 (1.6)	61 (2.5)	58 (2.3)
[2] Ontario Province, Canada	63 (3.1)	51 (3.1)	82 (2.1)	86 (2.1)	84 (2.2)	68 (2.7)	68 (3.3)	23 (2.8)	84 (1.9)	56 (3.1)	37 (3.0)
Russian Federation	62 (2.9)	59 (3.7)	72 (3.6)	96 (1.1)	77 (2.3)	52 (3.9)	56 (3.1)	55 (3.0)	75 (2.5)	36 (3.3)	35 (2.7)
Singapore	85 (3.1)	71 (3.9)	98 (1.2)	97 (1.5)	94 (2.0)	85 (2.8)	80 (3.4)	43 (4.3)	89 (2.8)	65 (3.5)	45 (4.3)
Slovak Republic	57 (2.8)	58 (3.0)	89 (1.7)	77 (2.4)	76 (2.2)	54 (2.7)	51 (3.0)	42 (2.6)	80 (2.2)	47 (2.8)	61 (2.7)
Slovenia	51 (2.8)	45 (2.6)	93 (1.5)	67 (2.6)	63 (2.5)	47 (2.7)	32 (2.5)	12 (2.0)	87 (1.7)	38 (2.9)	24 (2.4)
South Africa	72 (2.6)	61 (2.7)	46 (2.1)	71 (2.7)	77 (2.3)	63 (2.8)	63 (2.5)	30 (2.2)	82 (2.3)	38 (2.4)	28 (2.4)
[1] Thailand	89 (2.0)	90 (1.8)	75 (2.4)	87 (2.1)	87 (2.0)	68 (2.7)	84 (2.1)	84 (2.1)	90 (1.6)	58 (2.7)	48 (2.7)
[#] Denmark	76 (3.0)	56 (3.6)	67 (3.0)	63 (3.6)	76 (2.9)	63 (3.4)	43 (3.6)	52 (3.7)	54 (4.0)	50 (3.5)	34 (3.5)
[#] Estonia	43 (3.8)	45 (3.5)	75 (2.9)	84 (3.0)	89 (2.6)	44 (3.6)	65 (3.4)	36 (3.1)	65 (3.9)	15 (2.5)	40 (3.4)
[#] France	30 (3.0)	44 (3.8)	52 (3.4)	59 (3.8)	47 (3.8)	53 (3.9)	48 (3.5)	56 (3.9)	60 (3.4)	34 (3.1)	5 (1.4)
[#] Norway	80 (3.3)	56 (3.9)	46 (4.0)	84 (2.8)	82 (2.8)	61 (3.8)	69 (3.7)	69 (3.9)	52 (4.1)	27 (3.3)	41 (3.7)

Notes:

[#] School participation rate after including replacement schools is below 70%

[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Less than 70% of the school-level questionnaires in the participating schools were returned

[4] Nationally defined population covers less than 90% of the nationally desired population.

Table 4.19 Percentages (standard errors) of schools that had taken particular actions (monthly or weekly) regarding internal and external communication

Education system	Activities to develop common vision	Inform teachers ped. changes in school	Inform teachers ped. changes outside school	Consult teachers of desired ped. changes	Discuss what teachers want to achieve	Motivate teachers to assess own eductional practices	Encourge teachers assess practices against school goals
[2,3] Alberta Province, Canada	38 (3.9)	59 (2.9)	64 (3.4)	44 (3.9)	39 (3.7)	53 (4.0)	52 (3.8)
Catalonia, Spain	32 (2.3)	45 (2.8)	30 (2.4)	33 (2.9)	31 (2.5)	24 (2.3)	28 (2.7)
[1] Chile	73 (2.2)	83 (1.8)	63 (2.3)	70 (2.1)	78 (2.0)	82 (2.0)	78 (2.0)
Chinese Taipei	28 (2.4)	34 (2.6)	30 (2.7)	26 (2.0)	35 (2.4)	30 (2.4)	32 (2.4)
[2] Finland	9 (1.8)	26 (2.9)	22 (2.7)	20 (2.4)	23 (2.6)	20 (2.5)	17 (2.3)
[2] Hong Kong SAR	8 (1.9)	22 (3.2)	23 (3.0)	8 (2.1)	13 (2.1)	17 (2.4)	18 (2.6)
[4] Israel	37 (3.2)	55 (3.4)	40 (3.8)	49 (3.0)	42 (3.1)	36 (3.1)	36 (3.0)
[1] Italy	17 (2.3)	31 (2.8)	21 (2.4)	31 (2.7)	45 (3.0)	45 (3.0)	48 (3.0)
[1] Japan	17 (2.0)	7 (1.4)	18 (1.9)	18 (2.2)	17 (2.1)	7 (1.3)	26 (2.3)
[2] Lithuania	11 (2.2)	47 (3.5)	56 (3.5)	52 (3.9)	42 (3.7)	28 (3.4)	28 (3.6)
Moscow, Russian Federation	40 (2.2)	76 (2.0)	37 (2.7)	59 (2.8)	67 (2.5)	56 (2.5)	34 (2.3)
[2] Ontario Province, Canada	51 (3.0)	72 (2.6)	75 (2.7)	59 (2.9)	44 (3.1)	62 (3.3)	60 (3.1)
Russian Federation	26 (2.4)	65 (3.0)	37 (2.4)	41 (2.8)	58 (2.6)	43 (3.2)	29 (3.8)
Singapore	35 (4.1)	49 (3.9)	48 (3.9)	42 (4.0)	49 (3.8)	53 (3.8)	51 (3.9)
Slovak Republic	50 (2.7)	90 (1.7)	84 (2.1)	74 (2.5)	72 (2.4)	71 (2.4)	67 (2.6)
Slovenia	29 (2.5)	82 (2.4)	54 (2.8)	58 (2.6)	41 (2.8)	33 (2.5)	33 (2.3)
South Africa	31 (2.6)	55 (2.6)	53 (2.5)	49 (2.6)	57 (2.6)	61 (2.6)	62 (2.7)
[1] Thailand	43 (2.8)	57 (3.0)	67 (2.6)	65 (3.0)	68 (2.9)	70 (2.7)	68 (2.7)
[#] Denmark	24 (3.1)	56 (3.5)	38 (3.8)	45 (3.5)	35 (3.2)	40 (3.7)	46 (3.7)
[#] Estonia	15 (2.6)	46 (3.7)	34 (3.3)	30 (3.4)	31 (3.3)	23 (3.0)	29 (3.6)
[#] France	5 (1.9)	21 (3.1)	11 (2.3)	20 (3.0)	22 (3.1)	19 (2.6)	22 (2.6)
[#] Norway	22 (3.5)	47 (3.6)	30 (3.6)	39 (3.7)	39 (3.8)	31 (3.6)	20 (3.3)

Notes :

[#] School participation rate after including replacement schools is below 70%

[1] School participation rate before including replacement schools is below 85%

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[4] Nationally defined population covers less than 90% of the nationally desired population.

4.3 School principals' perceptions of the presence of lifelong learning pedagogy in schools: A comparison between 1998 and 2006

As explained in Chapter 1, SITES Module 1 was a school-level survey. According to Pelgrum (2001), the study's participants wanted to gain a better understanding of what was happening in schools with regard to

Table 4.19 Percentages (standard errors) of schools that had taken particular actions (monthly or weekly) regarding internal and external communication (Continued)

	Education system	Discuss ped.changes with parents	Discuss teaching and learning with students	Teachers co-teach	Teachers cooperate with colleagues from other schools	Teachers discuss problems with colleagues	Teachers collaborate with teachers from other countries
2,3	Alberta Province, Canada	33 (3.4)	38 (3.7)	78 (3.6)	90 (2.5)	98 (1.3)	24 (3.3)
	Catalonia, Spain	8 (1.5)	7 (1.6)	94 (1.2)	91 (1.5)	97 (1.0)	88 (1.8)
1	Chile	51 (2.7)	46 (2.5)	94 (1.2)	84 (1.7)	97 (0.9)	70 (2.2)
	Chinese Taipei	14 (1.9)	20 (2.1)	98 (0.7)	97 (0.8)	100 (0.3)	89 (1.8)
2	Finland	8 (1.8)	31 (2.6)	82 (2.6)	75 (3.0)	99 (0.7)	59 (3.5)
2	Hong Kong SAR	5 (1.6)	7 (2.2)	92 (1.8)	87 (2.5)	99 (0.6)	71 (3.4)
4	Israel	23 (2.8)	21 (2.9)	79 (2.6)	58 (3.0)	93 (1.5)	34 (2.6)
1	Italy	25 (2.7)	14 (2.0)	96 (1.1)	97 (1.0)	99 (0.6)	93 (1.5)
1	Japan	3 (0.9)	3 (0.9)	99 (0.6)	96 (0.9)	100 (0.0)	91 (1.4)
2	Lithuania	9 (1.7)	39 (3.3)	82 (3.0)	98 (1.0)	100 (0.0)	66 (3.6)
	Moscow, Russian Federation	20 (2.2)	42 (2.5)	99 (0.4)	92 (1.4)	100 (0.0)	69 (2.6)
2	Ontario Province, Canada	43 (2.8)	42 (3.0)	91 (1.7)	94 (1.4)	98 (0.7)	27 (2.6)
	Russian Federation	18 (2.5)	38 (3.6)	98 (0.8)	95 (1.0)	100 (0.2)	61 (3.2)
	Singapore	10 (2.6)	21 (3.0)	97 (1.5)	93 (1.9)	100 (0.0)	71 (3.5)
	Slovak Republic	34 (2.5)	56 (2.6)	45 (2.7)	93 (1.4)	100 (0.2)	75 (2.4)
	Slovenia	15 (2.0)	27 (2.4)	92 (1.5)	94 (1.2)	98 (0.7)	71 (2.3)
	South Africa	24 (2.2)	55 (2.5)	95 (1.1)	96 (1.1)	97 (0.8)	65 (2.7)
1	Thailand	33 (2.9)	63 (3.0)	99 (0.4)	98 (0.8)	98 (0.7)	90 (1.9)
#	Denmark	28 (3.2)	24 (3.4)	93 (1.9)	56 (3.3)	99 (0.8)	45 (3.3)
#	Estonia	12 (2.5)	27 (3.5)	51 (3.7)	86 (2.7)	100 (0.0)	68 (3.6)
#	France	12 (1.9)	3 (1.2)	91 (2.2)	91 (2.0)	98 (0.9)	91 (1.8)
#	Norway	14 (2.9)	12 (2.6)	93 (2.1)	71 (3.6)	97 (1.5)	35 (4.2)

Notes :

School participation rate after including replacement schools is below 70%

[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Less than 70% of the school-level questionnaires in the participating schools were returned

[4] Nationally defined population covers less than 90% of the nationally desired population.

the pedagogical approaches being used within them. This objective was behind one of the questions addressed to school principals involved in SITES Module 1. Specifically, the question asked the principals to state the extent to which each of the following emerging pedagogical practices was present in their schools:

- Students develop abilities to undertake independent learning
- Students learn to search for, process, and present information

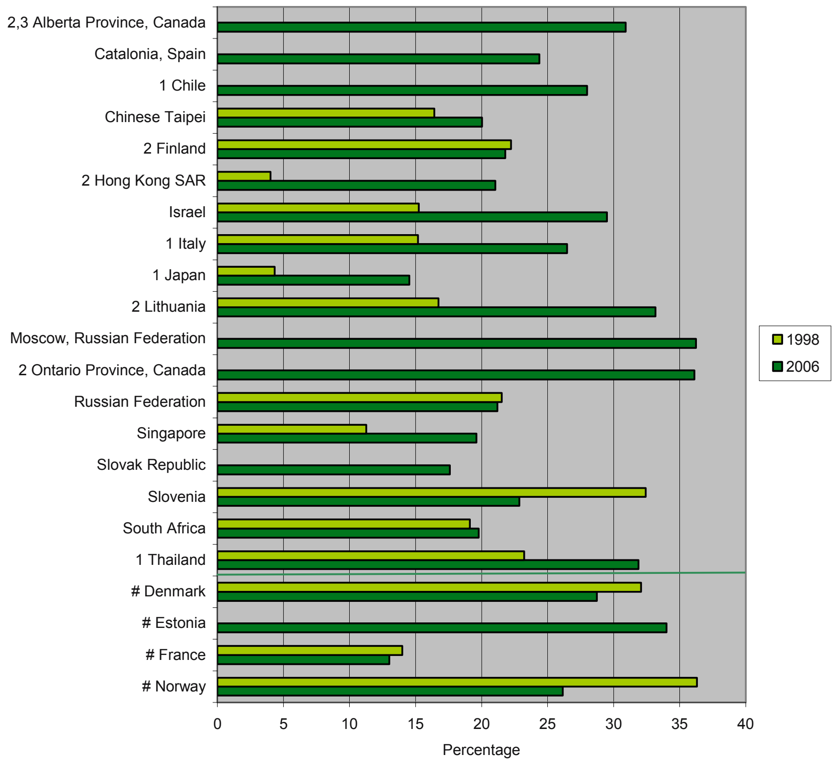
- Students are largely responsible for controlling their own learning progress
- Students learn and/or work during lessons at their own pace
- Students are involved in cooperative and/or project-based learning
- Students determine for themselves when to take a test.

This question was also asked of the school principals participating in SITES 2006. To allow comparison of the data from 1998 with that from 2006, the average percentage of school principals indicating these practices were present "a lot" was calculated for both data sets. The reliabilities of this indicator were satisfactory. Figure 4.6 presents the results. In 1998, Denmark, Norway, and Slovenia had relatively high percentages on this indicator, but by 2006, their percentages had decreased. Conversely, a number of education systems with relatively low percentages in 1998 showed a substantial increase over the eight years. Noteworthy are the results in Hong Kong, Japan, Israel, Italy, and Lithuania. The Danish colleagues who participated in SITES 2006 offered the following comment: "The fact that the presence of reform-oriented practice has decreased may have something to do with a change in educational policy in Denmark where a mostly reform-oriented policy is being replaced by an increased interest in tests and subject-related matters."

It is also useful to inspect changes across time in the statistics for the individual items that underlie the indicators in Figure 4.6. These item-level statistics are included in Table W4.5 (at http://www.sites2006.net/appendix), and a number of observations can be drawn from this information:

- The emphasis on information-handling increased in a substantial number of countries across the eight years (e.g., Chinese Taipei, +18%; Denmark, +20%; France, +11%; Hong Kong, +39%; Israel, +22%; Japan, +23%; and Singapore, +16%).
- Relatively noteworthy changes occurred in relation to individual items. These included, amongst others, independent learning (Denmark, -16%; France, -12%; Hong Kong, +19%; Israel, +27%; Norway, -27%; Russian Federation, 8%); learning at own pace (Denmark, -11%, Italy, +31%; Russian Federation, -18%; Slovenia, -24%); cooperative and project-based learning (Denmark: -12%; Hong Kong, +29%; Italy, +29%; Japan, +24; Russian Federation, +24%; Singapore, +24%); and students controlling their own learning process (Slovenia, -24%).

Figure 4.6 Percentages of school principals averaged across a set of items indicating "a lot" of presence of emerging pedagogy in SITES–M1 (1998) and SITES 2006 (2006)[1]



Notes:
See footnote at the end of this chapter for information about comparability; Missing bars = data not collected
[#]School participation rate after including replacement schools is below 70%
[1]School participation rate before including replacement schools is below 85%
[2]School participation rate after including replacement schools is below 85%
[3]Less than 70% of the school-level questionnaires in the participating schools were returned
[4]Nationally defined population covers less than 90% of the nationally desired population.

- No major changes were observed in Finland, but substantial increases for nearly all items showed up in Lithuania and Thailand. Most noteworthy in Thailand was the increased focus on learning at one's own pace (from 32% to 56%).

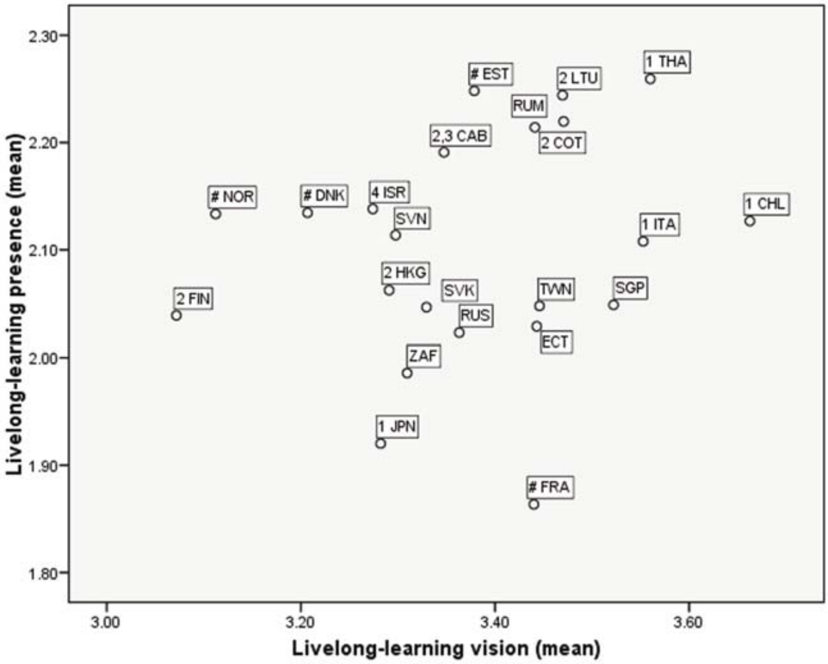
It appears, from this overview, that the most noteworthy change between 1998 and 2006 was the increase in pedagogical practices involving information-handling (i.e., searching for information, processing data, and presenting information). This change aligns with what might be expected given the increasing availability of the internet within the education systems. The picture is not so clear cut with respect to independent learning, however. This indicator showed an increase in some systems and a decline in others.

An interesting question arising from these results is whether the differences between education systems with regard to the vision that principals had of pedagogical-related lifelong learning ("lifelong-learning vision"; refer Table 4.1) were consistent with the principals' perception that these practices were actually occurring in their schools. The data presented in Figure 4.7 allowed examination of this issue. Here we can see that the positions of the education systems in terms of the scores (averaged across six items) for both indicators and that there is indeed, overall, some co-variation between the visions of the school principals and their perceptions of their existence in their schools. However, there are also a few interesting exceptions:

- In Norway, Finland, and Denmark, lifelong learning-pedagogical practices were more prevalent than we might have expected on the basis of the principals' visions. Assuming that practice usually follows vision, this finding prompts the question of whether, in these education systems, school managements were no longer so certain that student-centered pedagogical approaches are relevant.
- The opposite seems to be the case in France and Japan, where the school principals appear to have been somewhat more innovation-oriented relative to the practices actually taking place in the schools. Could this mean that the visions of these principals were ahead of those of the teachers?

But are principals good informants about what is happening in the classrooms in their schools? If the results from the principals produced the same pattern of differences between systems as did the results from the teachers, then we would have a basis for arguing that principals are good informants. A first exploration with regard to this matter was conducted by comparing the answers from the teachers with the perception of principals regarding the presence of lifelong-learning-oriented practices. Teachers reported how often students engaged in a number of such practices. For each teacher, the average score across these items was calculated (similar to the score calculation for the presence of lifelong-learning practices for principals).

Figure 4.7 Mean score on indicators of the lifelong-learning vision of school principals and perceived presence of this pedagogical paradigm



Notes:
Response categories for lifelong-learning vision: 1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree; for lifelong learning presence: 1=not at all, 2= to some extent, 3= a lot
For country abbreviations, see Table 1.1
[#] School participation rate after including replacement schools is below 70%
[1] School participation rate before including replacement schools is below 85%
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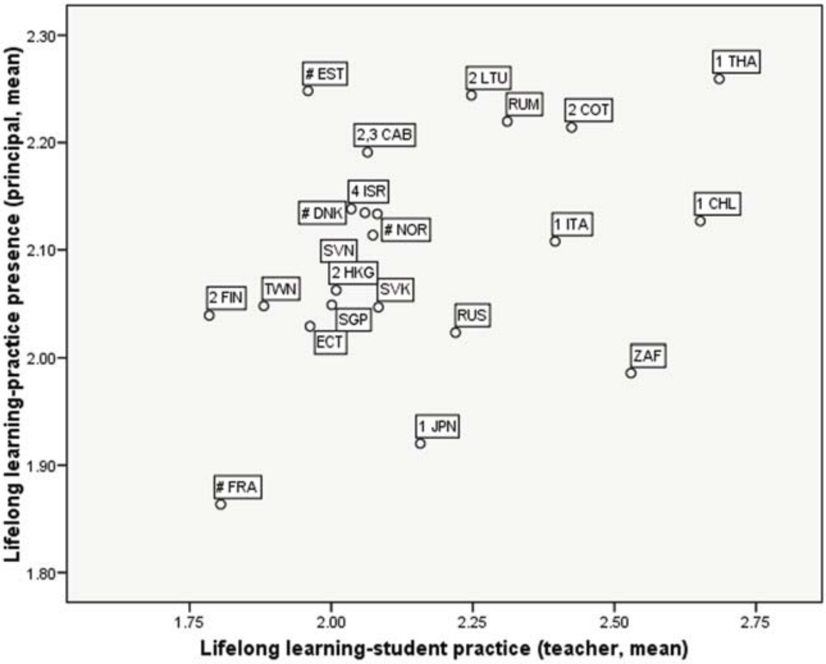
The scatter diagram in Figure 4.8 indicates that, overall, these indicators converged at an aggregated level. Although the co-variation between both indicators stands out as a first overall impression of Figure 4.8, there are exceptions to the overall patterns, such as Estonia (EST), where school principals perceived relatively more lifelong-learning activities than teachers reported, versus Chile (CHL), Japan (JPN), and South Africa (ZAF), where the opposite is evident. The reasons behind these exceptions are not yet well understood and so need further investigation.

Figure 4.8 Mean score on indicators of presence of lifelong-learning-oriented practices (by school principals) and perceptions of students' engagement in these types of activities by teachers



Notes:
Response categories for lifelong-learning vision: 1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree; for lifelong learning presence: 1=not at all, 2= to some extent, 3= a lot
For country abbreviations, see Table 1.1
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4.4 Relationships between school-level conditions

This chapter has produced a set of snapshots of the teaching and learning contexts in schools with respect to ICT. Overall, we can discern a great deal of variation within and between education systems with regard to conditions in schools. The working hypothesis was that these factors would not only be conditional for teaching and learning, but that they would also be interdependent. The goal of this section, therefore, was to discern correlations among the following sets of school-level indicators:

- *Existence of lifelong-learning pedagogy in the school*: the percentage of school leaders reporting that lifelong learning activities were present a lot in their school
- *Vision on lifelong-learning pedagogy*: the extent to which school leaders encouraged teachers to provide opportunities to students to involve themselves in learning activities that foster lifelong-learning skills
- *Vision on connectedness*: the extent to which school leaders were encouraging teachers to take up opportunities to learn from outside experts or peers and to be involved in communication activities
- *Vision on ICT for lifelong learning*: the importance that school leaders ascribed to using ICT to foster the lifelong-learning skills of students
- *Training needs of principals*: the extent to which principals felt a need to acquire competencies in managing change (such as developing a common vision, motivating teachers, promoting cooperation between teachers, cooperating with other schools, etc.)
- *Training requirements for teachers*: the extent to which teachers were required to acquire knowledge and skills related to lifelong-learning pedagogy (such as developing real-life assignments, engaging in team-teaching, and learning how to integrate ICT into teaching and learning, etc.)
- *Hardware availability*: the student–computer ratio
- *Hardware connectedness*: the student–internet-computer ratio
- *Software*: the extent to which a range of software tools was available
- *Technical support*: the extent to which technical support was available to teachers utilizing lifelong-learning pedagogy
- *Pedagogical support*: the extent to which pedagogical support was available for teachers utilizing lifelong-learning pedagogy
- *Number of years experience with ICT*: the number of years that the schools had been using ICT for teaching and learning purposes for students at the targeted grade level.

It is important to emphasize that questions relating to these indicators pertain to conditions existing at the school level. Questions that cut across levels are considered in Chapter 8.

The correlation matrix displayed in Table 4.20 provides support for several claims:

- In systems where the presence of lifelong-learning pedagogical practices was high, school leaders tended to have higher training needs with regard to change management
- In education systems where the vision indicators for lifelong-learning and connectedness were high, schools had less experience with ICT than did systems where these scores were lower
- High correlations emerged between the infrastructure indicators. The negative correlations for student–computer ratio and student–internet-computer ratio with other variables can be interpreted positively in that education systems with schools with a high availability of computers are not only likely to have a high availability of software but also to have had relatively long experience in using ICT. In those systems where software availability was high, the training needs of principals and requirements for training of teachers tended to be lower. The pattern of correlations evident here seems to relate to the number of years of experience with ICT and strongly suggests that the time when training is most needed is during the start-up phase.

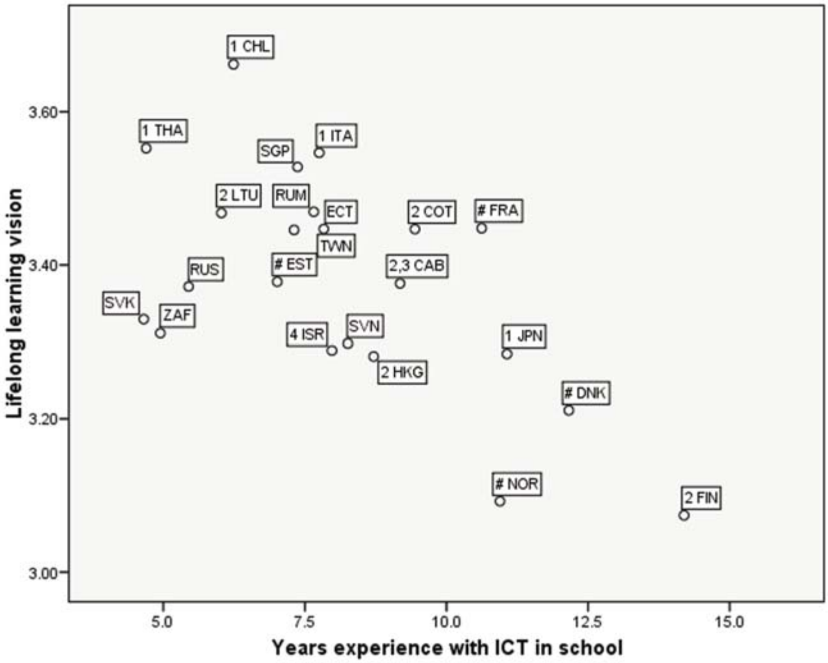
Table 4.20 Correlations between school-level indicators aggregated at the system level (including only those education systems which met the sampling standards)

	Indicator	A	B	C	D	E	F	G	H	I	J	K
A	Existence lifelong learning pedgagogy											
B	Vision lifelong learning	[illegible]										
C	Vision connectedness	[illegible]	[illegible]									
D	Vision [illegible] for lifelong learning	[illegible]	[illegible]	[illegible]								
E	Leadership development priorities	[illegible]	[illegible]	[illegible]	[illegible]							
F	Requirements for teacher training	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
G	Pedagogical support	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					
H	Technical support	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				
I	Student computer ratio	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
J	Student internet computer ratio	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
K	Software availability	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
L	Years experience with [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

* Significant at $p < 0.05$

The negative correlation between years of experience with ICT and other indicators in Table 4.20 (and further illustrated in Figure 4.9) is surprising when set against rhetoric on the need for educational reforms resulting from societal change. According to this rhetoric, ICT requires and facilitates the implementation of pedagogical changes that lead to more authentic, motivating, personalized, and autonomous learning. Many national policy plans make a direct link between reform initiatives and improvements to schools' ICT-infrastructure (Plomp, Anderson, Law, & Quale, 2003). This is a time-consuming process, and many years can elapse before real change is evident. A first step toward adopting change is therefore the existence of a reform-oriented vision.

Figure 4.9 Mean score on indicators of lifelong-learning-pedagogical vision and the number of years education systems had experience with ICT



Notes:
Response categories for lifelong-learning vision: 1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree; for lifelong learning presence: 1=not at all, 2= to some extent, 3= a lot
For country abbreviations, see Table 1.1
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With these notions in mind, we can hypothesize that the reform-oriented pedagogical vision of school leaders from education systems with relatively long experience with ICT will be more pronounced than the vision of leaders in systems with less experience. The data did not support this hypothesis, a situation that raises questions that need to be addressed through secondary analyses. One question of particular interest in this regard is to what extent economic welfare underlies these simple co-variations. Could it be that the education systems that had recently introduced ICT were at the top of their reform ambitions, while the systems that had started much earlier were on their way back from the top?

4.5 Summary

This chapter examined data collected at the school level in SITES 2006 with respect to six conceptual domains: pedagogical practices, vision, infrastructure, staff development, support, and organization and structure. The following sub-sections summarize the major findings regarding each of these domains.

4.5.1 Pedagogical practices

The trend analyses regarding the presence of lifelong-learning practices as perceived by school principals suggest that the most noteworthy change between the SITES assessments of 1998 and 2006 was the increase in pedagogical practices involving information-handling (searching for information, processing data, and presenting information). This finding is not unexpected given the increasing availability of the internet. Overall, though, the picture in relation to the trend indicators is one of diversity, with some systems placing greater emphasis over time on autonomous learning of students, and other systems apparently placing less.

4.5.2 Vision of school leaders on pedagogy and ICT

The indicators of the vision of school leaders regarding pedagogy were operationalized in terms of the extent to which principals encouraged their teachers to adopt certain pedagogical approaches. The results showed that although principals were promoting all three visions (traditional, lifelong learning, and connectedness), they tended to give less support to connectedness than to the other two.

School leaders generally underscored the importance of using ICT for pedagogical approaches deemed important for lifelong learning. However, there were substantial differences among the education systems in this regard. In some systems, school leaders seemed, for example, relatively inactive in terms of trying to influence the pedagogical practices of their teachers, while in other systems they tended to be much more active in this regard.

4.5.3 Infrastructure

In 1998, a substantial number of education systems still had schools without access to computers. However, by 2006, almost all schools in all participating education systems (except South Africa) were able to provide students at the target grade level with access to computers. Furthermore, in almost all education systems, schools that had access to computers also had access to the internet. Quite substantial increases in access to the internet took place in most education systems between 1998 and 2006.

Huge differences were observed between education systems in terms of ICT-infrastructural conditions. Some education systems had "very favorable" student–computer ratios (fewer than 5 students per computer) at more than half of their schools; other had "favorable" ratios (fewer than 10) at more than half of their schools. Some systems (in particular, and as expected, the developing economies) had yet to reach these levels, and in quite a few other systems, barely any schools had student–computer ratios of under 10. Very large ratio variations also existed within education systems, a finding that points to the existence of serious inequities between schools in terms of possibilities for students to access computers. This equity issue is no doubt an important one for policymakers to address in forthcoming years.

Although we might expect that students increasingly will bring their own equipment to schools, this practice was evident in only a few education systems in 2006. As to the equipment that respondents signaled were needed, smart boards and learning management systems tended to top the list. However—and again as expected—systems varied to a fair degree in terms of the priorities they placed on acquiring various items of ICT-infrastructure.

4.5.4 Pedagogical and technical support

A large degree of variation was observed between education systems with regard to indicators of the availability of pedagogical and technical support for teachers.

4.5.5 Staff development

In most education systems, hardly any or a minority of the schools required teachers to be trained in a variety of areas dealing with new pedagogy and ICT. The availability of courses also differed substantially across education systems. Overall, substantial numbers of school principals perceived a strong need to acquire competencies that would allow them to develop a common pedagogical vision among their teaching staff. However, with other aspects, the differences between education systems were quite remarkable.

4.5.6 Organization and structure

A re-allocation of workload to allow for collaborative planning had taken place in 80% or more of the schools in some education systems. The re-allocation was considerably less evident in the remaining systems. Reviewing the pedagogical approaches that teachers were using vis-à-vis ICT was a relatively popular practice in a majority of schools in most education systems, while implementing incentive schemes to encourage teachers to use ICT in lessons was occurring in some education systems, but barely in others. This same pattern was evident for involving parents in ICT-related pedagogy. Finally, differences between education systems were particularly apparent in regard to different actions relating to change management.

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[1] The sample of schools in SITES-M1 was drawn with a probability proportional to size (PPS) in order to allow for generalization of statistics to the population of students. SITES 2006 used a sampling design in which schools were randomly sampled from the population of schools in order to allow for statistical generalizations to the whole population of schools. Compensating for this difference required new calculations to be done for the SITES-M1 statistics. These used a sampling weight that corrected for the over-representation on large schools, so that the resulting sampling statistic could be generalized to the population of schools rather than to the population of students. It should also be noted that in SITES-M1, the sample of schools consisted of schools using ICT for instructional purposes at the targeted grade range. The SITES 2006 samples were focused on all schools. Hence, with regard to this aspect, the samples are comparable if both in 1998 and 2006 all targeted schools were using ICT. Figure 4.6 shows that in 1998 sizable numbers of schools in Israel, Italy, Lithuania, the Russian Federation, and Thailand were not yet using ICT, while in 2006, ICT-use was almost 100%. In South Africa, 18% of the schools were using ICT in 1998; by 2008, 38% were doing so. These countries should therefore be treated with caution during interpretation of the comparative statistics. Another issue regarding comparability is the sampling quality. As can be observed in all tables and figures containing 2006 school-level data, the sampling quality of school samples in Denmark, Estonia, France, and Norway was qualified by the IEA sampling referee as not satisfying the IEA sampling standards. In 1998, this was the case for Finland, Israel, Italy, the Russian Federation, and South Africa.

Chapter Five

Pedagogical Orientations in Mathematics and Science and the Use of ICT

Nancy LAW and Angela CHOW

Teachers' pedagogical practices and the use of ICT in them lie at the core of the entire SITES survey program. The key concern driving policy and community interest in the pedagogical integration of ICT is the premise that ICT is important for bringing changes to classroom teaching and learning so as to foster the development of students' 21st-century skills. Specifically, these skills include the ability to become *lifelong learners* within a context of collaborative inquiry and the ability to work and learn from experts and peers in a *connected* global community. In this chapter, we endeavor to answer the research question, *"What are the pedagogical practices adopted by teachers in schools and how is ICT used in them?"* We are also concerned with examining the impacts of ICT-use on teachers and students as perceived by the teachers themselves.

As described in Chapter 2, the pedagogical practices considered in this study are broadly categorized into *traditionally important* and *21st-century* orientations. The former refers to practices characteristic of classrooms in the industrial society, such as teachers giving instructions and students responding to quizzes and tests; the latter are practices considered conducive to developing learning outcomes important for the knowledge society, such as undertaking autonomous learning, collaborative inquiry, and communication through use of appropriate digital technology. The 21st-century pedagogical orientation can be

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further delineated into two areas of consideration. The first is *lifelong learning*. This includes the use of more collaborative-, inquiry-, and production-oriented activities as well as strategies designed to take greater account of individual differences, such as provision of remedial instructions. The second is *connectedness*, which refers to activities in which students collaborate with and/or learn from outside peers and experts to create products and publish results.

To provide a more comprehensive understanding of teachers' pedagogical practices, the SITES research team designed the teacher questionnaire to provide three sets of core indicators for pedagogical orientations—curriculum-goal, teacher-practice, and student-practice orientations—and two further sets of core indicators for the "ICT-using teacher-practice orientation" and the "ICT-using student-practice orientation." Information was also collected on specific aspects of teaching and learning situations, including methods of organizing teaching and learning activities, types of learning resources used, assessment methods adopted, and whether teachers were using ICT for various pedagogical situations.

Before we report the actual findings, it is important to reiterate a point made in the sampling section in Chapter 2. While the samples of mathematics teachers and science teachers were drawn from the same set of sampled schools, they were treated as separate populations and the sampling weights were computed independently so as to permit generalizations on these two populations of Grade 8 teachers.

5.1 Pedagogical orientations of mathematics and science teachers around the world

As mentioned, three sets of core indicators were developed to help us understand the teachers' pedagogical orientations. In this section, we report findings related to the curriculum-goal orientations, teacher-practice orientations, and student-practice orientations respectively. The section concludes with a summary that compares the three orientations.

5.1.1 Pedagogical-practice orientations as reflected in teachers' espoused curriculum goals

To determine what priorities teachers assigned to different curriculum goals, the SITES 2006 teacher questionnaire asked for responses to the question, *"In your teaching of the target class in this school year, how important is it for you to achieve the following goals?"* Of the 12 goals listed in this question, the three highest-ranked goals were: to *increase learning motivation*, to *prepare students for upper secondary education and beyond,* and to *improve assessment performance.* These three goals were all ranked as very important by both mathematics and science teachers in all systems, with scores above 3.0 on a four-point Likert scale (1=not at all, 2=a little, 3=somewhat, 4=very much).

The lowest-ranked goal for both teacher populations was to *learn from experts and peers from other schools/countries*: scores were below 3.0 in all systems except South Africa. This goal would have been difficult to operationalize before the advent of the internet. To *prepare students for competent ICT-use*, to *prepare students for responsible internet behavior* and to *foster communication skills online and offline* were also ranked as relatively less important, with a mean score below 3.0 for both teacher populations in the majority of systems.

Exploratory factor analysis found that 10 of the items in this question could be used to provide three scale scores for curriculum-goal orientations. These items are presented in Box 5.1 according to the factors they belong to. The first set of items relates to helping students to achieve good assessment performance and to pursue further education, which are traditionally important goals. The second group of goals relates to individualizing learning and giving students opportunities to undertake collaborative inquiry on authentic, real-life problems, and hence are labeled lifelong-learning goals. The third group of goals focuses on providing students with opportunities to communicate and learn beyond the school walls (activity that includes responsible internet behavior), and is labeled connectedness-oriented goals. The most popular goal, *to increase learning motivation,* did not load well on any of the three orientations and therefore is not included in the computation of the scales.

As described in Chapter 2, SITES 2006 researchers used Cronbach alpha reliability scores to assess the statistical quality of the scale indicators; a value of 0.5 or above was taken as an acceptable quality measure for a scale indicator in the study.[1] In this study, the reliabilities

[1] There are different views on the minimum reliability necessary for a scale to be acceptable. Normally, it is easier for scales formed from more items to achieve higher reliability. In this study, in order not to make the questionnaire overly long, some of the scales were assigned only three items, which made it difficult for them to achieve a high reliability score. Arguments have been put forward for taking a Cronbach alpha value above 0.5 as satisfactory (Nunnally, 1978), and this was adopted as a marginally acceptable quality measure for a scale indicator in SITES 2006.

were computed for each participating system to determine if the statistical quality for forming a scale was met in each case. The reliabilities for the lifelong-learning and connectedness goal orientations were above 0.5—mostly 0.6 or higher—in all participating systems. However, the reliability for the traditionally important goal orientation was considerably lower, with only a few systems having marginally acceptable reliabilities between 0.44 and 0.5. This relatively low reliability for the traditionally important scale was observed in the corresponding teacher-practice and student-practice orientation scales and is discussed in a later section.

Box 5.1 List of curriculum-goal items contributing to the three goal-orientation scores

Curriculum-goal orientation	Specific curriculum goals included in the scales*
Traditionally important	• To prepare students for upper secondary education and beyond • To improve students' performance in assessment/examinations • To satisfy parental and community expectations
Lifelong learning	• To provide activities that incorporate real-world examples/settings/applications for student learning • To individualize student learning experiences in order to address different learning needs • To foster students' ability and readiness to set their own learning goals and to plan, monitor, and evaluate their own progress • To foster students' collaborative and organizational skills for working in teams
Connectedness	• To provide opportunities for students to learn from experts and peers from other schools/countries • To foster students' communication skills in face-to-face and/or online situations • To prepare students for responsible internet behavior

Note:
The scale scores are arithmetic means of the scores for the respective items of the scale.

Figure 5.1 presents the mean scores for the three curriculum-goal orientations for the mathematics and the science teachers in the participating systems. The results indicate that, in general, for both sets of teachers, the highest mean scores pertain to traditionally important goals (means ranging from 3.15 to 3.77 for mathematics teachers and from 3.02 to 3.75 for science teachers), followed very closely by *lifelong* *learning* goals (means ranging from 2.90 to 3.71 for mathematics teachers and from 2.95 to 3.71 for science teachers). The lowest mean scores are found for the connectedness goals (means ranging from 2.23 to 3.16 for mathematics teachers and from 2.39 to 3.18 for science teachers).

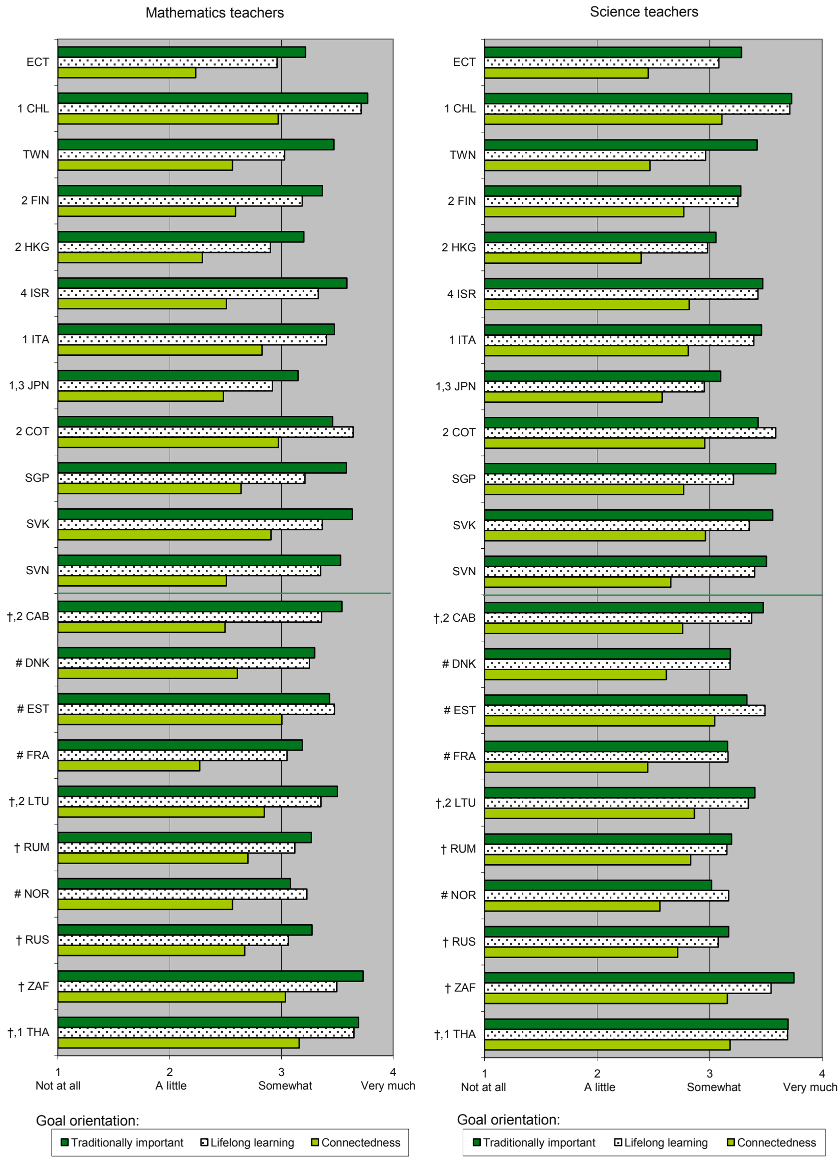
This pattern of relative importance for the three curriculum-goal orientations was consistently observed across the two teacher populations and across most of the participating systems; those variations that did occur were very minor. In Ontario-Canada, Estonia, and Norway, both mathematics teachers and science teachers saw the lifelong-learning goals as somewhat more important than the traditionally important ones. In Denmark and France, scores for traditionally important and lifelong-learning goals were essentially the same for the science teachers in each country. What is noteworthy is that, despite minor variations in the rank orderings, the scores for both types of goals were very close in magnitude, being nearly always above 3.0 (except for mathematics teachers in Chile, Hong Kong SAR, and Japan, and for science teachers in Chinese Taipei, Hong Kong, and Japan). The importance of connectedness as a curriculum goal was always the lowest, being below 3.0 in most systems and with some sizeable differences between this and the other two goal orientations in all cases.

5.1.2 Pedagogical-practice orientations as reflected in teachers' practices

Espoused curriculum goals reflect only one aspect of teachers' pedagogical-practice orientations. The survey contained another question that asked about the activities teachers engaged in: *"In your teaching of the target class in this school year, how often do you conduct the following?"* Reliability scores confirmed that the 12 teacher practices fell into three factors as presented in Box 5.2.

Traditionally important teacher practices include *present information/demonstrations and/or give class instructions*, *assess students' learning through tests/quizzes*, and *use classroom management to ensure an orderly, attentive classroom*. These practices are well-aligned in terms of helping students attain the *traditionally important* curriculum goals described in the previous section. Likewise, the six roles listed next to the lifelong-learning orientation depict more facilitative roles for the teacher that are suited to achieving lifelong-learning goals, such as tailoring instruction, providing advice and feedback to suit individual needs, and guiding and monitoring open-ended inquiry, collaboration, and team

Figure 5.1 Mathematics teachers' and science teachers' pedagogical-practice orientations as reflected in their espoused curriculum goals



Notes:

#School participation rate after including replacement schools is below 70%

†International procedures for target-class selection were not followed in all schools

1 School participation rate before including replacement schools is below 85%

2 School participation rate after including replacement schools is below 85%

3 Teacher participation data were collected after survey administration

4 Nationally defined population covers less than 90% of the nationally desired population.

building. In carrying out these lifelong-learning-oriented teacher practices, teachers not only have to be more student-centered but also become lifelong learners alongside the students when tackling new, authentic real-life problems.

Box 5.2 List of teacher practices associated with the three teacher-practice orientations

Teacher-practice orientation	Teacher practices (roles of the teacher)
Traditionally important	• Present information/demonstrations and/or give class instructions • Assess students' learning through tests/quizzes • Use classroom management to ensure an orderly, attentive classroom
Lifelong learning	• Provide remedial or enrichment instruction to individual students and/or small groups of students • Provide feedback to individuals and/or small groups of students • Provide counseling to individual students • Help/advise students in exploratory and inquiry activities • Organize, observe, or monitor student-led whole-class discussions, demonstrations, presentations • Organize, monitor, and support team-building and collaboration among students
Connectedness	• Organize and/or mediate communication between students and experts/external mentors • Liaise with collaborators (within or outside school) for student collaborative activities • Collaborate with parents/guardians/caretakers in supporting/monitoring students' learning and/or in providing counseling

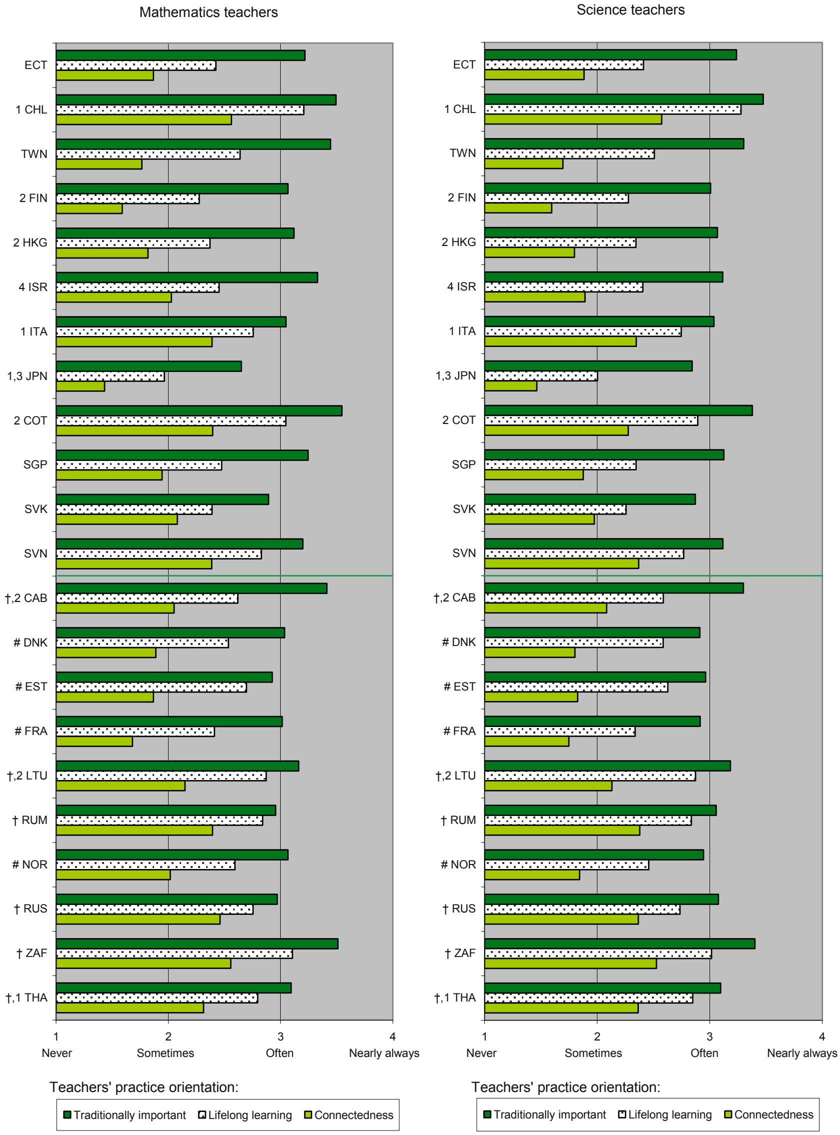
The third set of roles pertain to providing opportunities for students to work with and learn from peers and experts locally and/or internationally to achieve the *connectedness*-related goals: organizing and/or mediating with other parties to set up and/or facilitate the collaborations and communications. This last group of teacher practices requires teachers to extend their own connectedness, changing from working primarily within the confines of their classrooms to establishing collaborative relationships with peers, experts, and members of local and/or foreign communities.

The three roles most frequently played by mathematics and science teachers across systems belong to the traditionally important orientation: *classroom management* (means ranging from 2.73 to 3.83 for mathematics teachers and from 2.73 to 3.75 for science teachers), *present information or demonstration or give class instruction* (means ranging from 2.04 to 3.67 for mathematics teachers and from 2.63 to 3.58 for science teachers), and *assess students' learning* (means ranging from 2.28 to 3.57 for mathematics teachers and from 2.07 to 3.49 for science teachers) measured on a four-point Likert scale (1=never, 2=sometimes, 3=often, 4=nearly always). The teacher practices with the lowest frequencies of occurrence were *to organize or mediate communication with experts/external mentors* (means ranging from 1.20 to 2.56 for mathematics teachers and from 1.31 to 2.56 for science teachers), and *to liaise with collaborators* (means ranging from 1.29 to 2.42 for mathematics teachers and from 1.45 to 2.38 for science teachers). Both of these practices belong to the *connectedness* orientation. These results triangulate consistently with the relative importance of the three curriculum-goal orientations.

Cronbach alpha reliability scores were also computed for each system to assess the quality of the three teacher-practice orientation scales. The reliabilities for both the lifelong-learning and the connectedness scales were very good for all individual systems, with reliabilities of more than 0.63 and 0.56 respectively for mathematics teachers and more than 0.67 and 0.57 respectively for science teachers. However, the three items forming the traditionally important teacher-practices scale had a less satisfactory reliability at lower than 0.50 for the mathematics teachers in 10 systems: Denmark, Estonia, Finland, France, Japan, Moscow, Norway, the Slovak Republic, Slovenia, and the Russian Federation. The corresponding reliability statistics for science teachers were very similar, with some relatively low reliabilities registered in the traditionally important teacher-practice scale for some systems.

Why was it that the two scales underpinning the 21st-century pedagogical orientation—lifelong learning and connectedness—formed reliable scales for all participating systems while the reliability for the traditionally important teacher-practices scale had relatively low reliabilities for some of the participating systems? One possible explanation is that traditionally important practices are more diverse across systems. On the one hand, long-established teacher practices reflect historical and cultural differences that necessarily exist in

Figure 5.2 Pedagogical-practice orientations as reflected in mathematics teachers' and science teachers' practices



Notes:
[#]School participation rate after including replacement schools is below 70%
[†]International procedures for target-class selection were not followed in all schools
[1]School participation rate before including replacement schools is below 85%
[2]School participation rate after including replacement schools is below 85%
[3]Teacher participation data were collected after survey administration
[4]Nationally defined population covers less than 90% of the nationally desired population.

different systems, even though the traditionally important curriculum goals may be similar. On the other hand, the lifelong-learning and connectedness orientations are practices that have emerged only in recent years in response to the changes and demands arising out of a more globally connected knowledge society. Many countries around the world are debating which goals and pedagogies are more appropriate for the 21st century, and such debates are never entirely confined to their own national or local boundaries. Rather, there is often much effort to learn from the policies, practices, and research findings and experiences of other countries.

Despite the somewhat lower reliabilities for the traditionally important teacher-practice scale, it is still useful to examine the aggregate score of these items as a reference for comparison with the other scale scores. Figure 5.2 displays the clustered bar graphs of the teacher-practice orientations for the mathematics and the science teachers surveyed. Comparison of Figures 5.1 and 5.2 shows that for the two sets of curriculum goals and teacher-practice indicators, the traditionally important orientation ranked the highest and connectedness the lowest for both sets of teachers. However, the differences between the three goal orientations were relatively small for both teacher populations. In particular, the magnitudes of the lifelong-learning goal orientation were very close to those for the traditionally important goal orientation. In some instances, such as in Ontario, Estonia, and Norway, the lifelong-learning-goal orientation scores were higher than the respective scores for the traditionally important goals. However, the lifelong-learning teacher-practice orientation was markedly lower in importance than the traditionally important ones for both teacher populations. Unlike the case with curriculum-goal orientations, the former was not higher than the latter in any of the systems.

One interpretation of these observations is that the espoused curriculum goals reflected a relatively stronger inclination toward the 21st-century orientation of lifelong learning than did the actual extent of changes occurring in the roles played by teachers in mathematics and science classrooms. Another noteworthy observation is the greater cross-system differences between teachers' practice orientations than between teachers' goal orientations. This situation suggests that the participating systems were more similar in terms of their curriculum aspirations than in terms of their teachers' actual roles and teaching activities.

5.1.3 Pedagogical-practice orientations as reflected in teachers' reports of students' practices

Contemporary constructivist theories of learning attribute considerable importance to students' engagement in the learning process, as this is considered essential to deep learning. Therefore, the roles played by students in their learning practices arguably provide the most important information about the pedagogical orientation of any teaching and learning situation. The teachers accordingly were asked, *"In your teaching of the target class in this school year, how often do your students engage in the following activities?"* The respondents were instructed to indicate their rating for each of the 12 activities (see full listing in Box 5.3) on a four-point Likert scale (1=never, 2=sometimes, 3=often, and 4=nearly always). The responses to this question were used to compute the indicators for the student-practice orientation, which is the third set of core indicators on pedagogical orientation.

Box 5.3 List of items pertaining to the three student practices

Student-practice orientation	Student practices (roles of the student)
Traditionally important*	• Working on the same learning materials at the same pace and/or sequence • Complete worksheets, exercises • Answer tests or respond to evaluations
Lifelong learning	• Students learning and/or working during lessons at their own pace • Determine own content goals for learning (e.g., theme/topic for project) • Explain and discuss own ideas with teacher and peers • Give presentations • Engage in self- and/or peer-evaluation • Reflect on own learning experience
Connectedness	• Collaborate with peers from other schools within and/or outside the country • Communicate with outside parties (e.g., with experts) • Contribute to the community through their own learning activities (e.g., by conducting an environmental protection project)

Note:
No scale indicators were computed for the traditionally important student-practice orientation because the reliabilities for the items were too low for some systems.

The three most frequently practiced student activities reported by both mathematics and science teachers across all participating systems were *completing worksheets/exercises* (means ranging from 2.44 to 3.59 for mathematics teachers and from 2.39 to 3.39 for science teachers), *working at the same pace/sequence* (means ranging from 2.30 to 3.41 for mathematics teachers and from 2.28 to 3.40 for science teachers), and *answering tests* (means ranging from 2.08 to 3.49 for mathematics teachers and from 2.08 to 3.38 for science teachers). These student activities are ones commonly found in more traditional classrooms (Voogt, 2003), and the results reported here are consistent with the findings cited earlier that teachers valued the traditionally important curriculum goals most highly and played traditionally important roles most frequently. However, the mean frequencies for students' engagement, even in traditionally important activities, were lower than those for teachers' engagement in corresponding roles.

The three least frequently occurring student activities as reported by both mathematics and science teachers were *collaborating with peers from other schools* (means ranging from 1.07 to 1.83 for mathematics teachers and from 1.04 to 1.80 for science teachers), *contributing to the community through their own activities* (means ranging from 1.08 to 2.09 for mathematics teachers and from 1.21 to 2.18 for science teachers), and *communicating with outside experts* (means ranging from 1.14 to 1.95 for mathematics teachers and from 1.21 to 1.92 for science teachers). All of these belong to the connectedness orientation, but the low figures indicate that students rarely engage in collaboration or communication with outside parties, if at all. This level of students' engagement in connectedness practices was again lower than the corresponding level for teachers' engagement in such practices.

Box 5.3 (above) details the six activities listed against the lifelong-learning orientation. These activities require students to play a much more pro-active and responsible role in their learning than has traditionally been the case. Practices include *determining their own content goals for learning (e.g., theme/topic for project)*, *explaining and discussing their own ideas with teachers and peers*, and *giving presentations*. Some activities on this list require deep metacognitive engagement, such as *self- or peer-evaluations* and *reflection on one's own learning experience*. It is generally held in the literature that giving students a more responsible and contributive role in socially contextualized learning settings helps them develop the lifelong-learning abilities typically valued for effective functioning in the knowledge society.

To arrive at a set of statistically sound scale indicators for the student-practice orientation, we again explored, for each participating system, the reliability of the respective items in the three groups of student practices listed in Box 5.3. Similar to the situation with curriculum goals and teacher practices, the reliabilities for the lifelong-learning and the connectedness indicators for the student-practice orientations were statistically acceptable, being above 0.5 for all participating systems for both populations of teachers.

However, the reliabilities for the traditionally important items were even poorer than those for the teacher-practice orientation, with less than half of the participating systems showing reliabilities of 0.5 or higher. Specifically, for the mathematics- and the science-teacher populations, there were respectively only eight and nine out of 22 systems with reliabilities deemed statistically acceptable (i.e., ≥ 0.5) for the construction of a scale indicator from the three traditionally important student-practice items. The findings from this study indicate that there is even more variability in terms of what may be considered as traditionally important in student practices as compared to teacher practices. Hence, there is no scale indicator for the traditionally important student-practice orientation.

Having failed to develop a suitable scale indicator, we then explored the data further to identify a possible candidate among the three items for use as an indicator for traditionally important student practice. A careful inspection of the descriptive statistics for the three traditionally important student-practice items found that the item *complete worksheets/ exercises* had the highest overall mean and the highest mean score among most of the participating systems. Further, correlational analysis found that, except for four of the 22 participating systems, the other two items, w*orking on the same learning materials at the same pace and/or sequence* and *answer tests or respond to evaluations*, showed lower correlations with each other compared to their correlations with the item *complete worksheets and exercises*. Based on these explorations, we selected the mean score for the item *complete worksheets/exercises* as an indicator of traditionally important student practice, and it is this indicator that is used in the further analyses involving this concept described later in this book.

Figure 5.3 presents the mathematics teachers' and science teachers' pedagogical-practice orientations as reflected in the reported student practices. The profiles of the student-practice orientations were similar to those for the teacher-practice orientations, with traditionally important practices (represented by the completion of worksheets) as the most frequently practiced, followed by the lifelong-learning orientation; the least frequently practiced orientation was connectedness. We observed this pattern in all participating systems, except Italy, where the science teachers gave their highest rankings to lifelong-learning student practices, followed by traditionally important and then connectedness student practices.

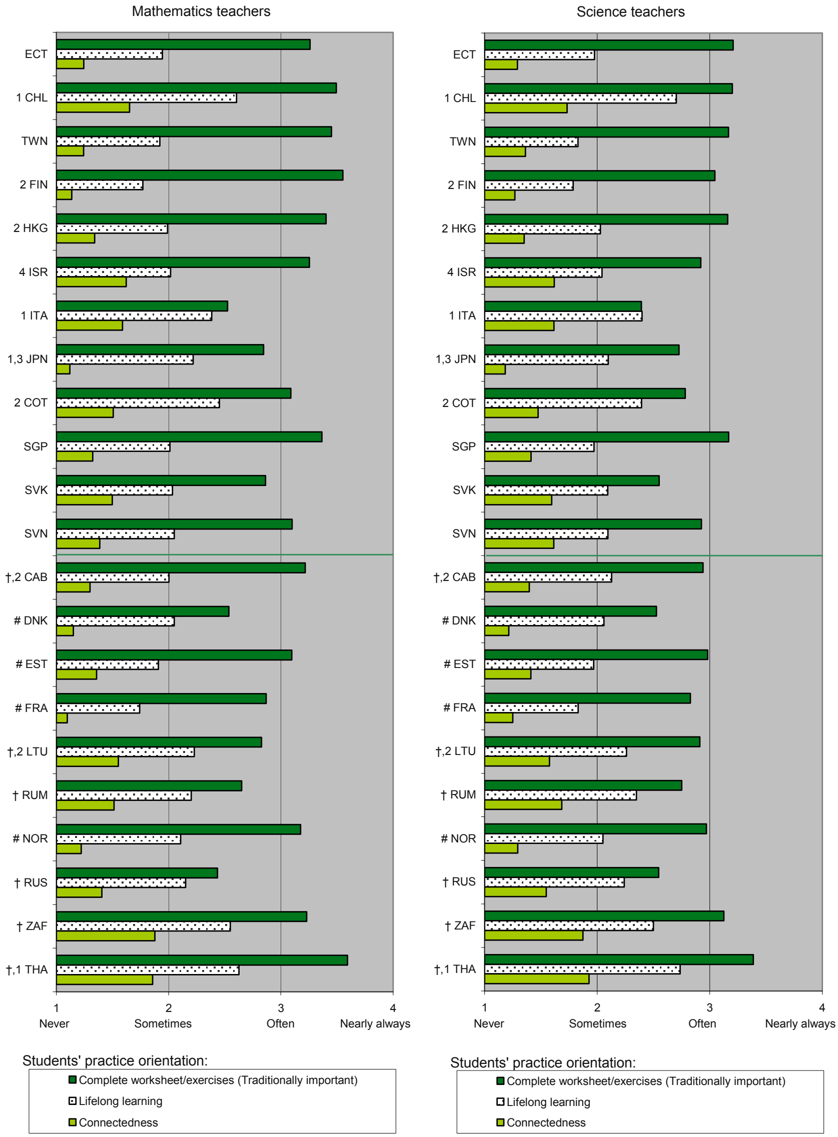
When comparing the mean scores for the student practice-orientations of the two populations of teachers, we found that, in almost all systems, mathematics teachers outweighed science teachers in the reported frequencies of students' engagement in *completing worksheets/exercises*. However, the science teachers reported higher connectedness scores than did mathematics teachers in almost all systems. This finding suggests that science teachers generally are more likely than mathematics teachers to adopt student practices conducive to the development of 21st-century competences.

5.1.4 Comparing the teacher-practice and student-practice orientations

Comparison of the pedagogical-orientation scores in Figure 5.3 with those in Figure 5.2 shows that, across the education systems, the student-practice scores were generally lower compared to the corresponding scores for teacher practice in all three orientations as reported by both mathematics and science teachers. This finding indicates that, in general, teachers were more likely than students to be engaged in pedagogical activities (i.e., students were generally playing a more passive role in the classroom). These lower levels of engagement by students were even more prominent for the 21st-century-oriented practices. One possible interpretation of these observations is that teachers are more ready to adopt newer practices in their teaching activities than to try out newer kinds of student activities. One interesting question that could be explored through future longitudinal studies is whether there is a developmental trajectory in pedagogical innovation—one that starts with a change in aspired curriculum goals, followed by a change in teacher practices, and finally a change in student practices. In addition to the information that emerged from our comparison of the magnitudes of the pedagogical practice scores, we found that much could be gained from examining the relative importance of the different orientations.

For example, in Figure 5.4, country A's mean teacher-practice scores for the three orientations were all equal to 3 and country B's respective mean scores were all equal to 2.5. What, therefore, could

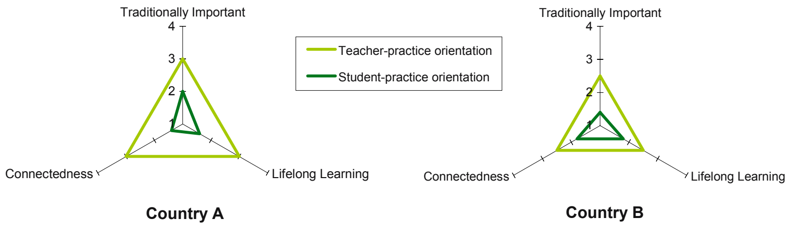
Figure 5.3 Pedagogical-practice orientations as reflected in students' practices and reported by mathematics teachers and science teachers



Notes:
#School participation rate after including replacement schools is below 70%
†International procedures for target-class selection were not followed in all schools
1School participation rate before including replacement schools is below 85%
2School participation rate after including replacement schools is below 85%
3Teacher participation data were collected after survey administration
4Nationally defined population covers less than 90% of the nationally desired population.

we say about the similarities and differences between the teachers' pedagogical-practice orientations in these two countries? On the one hand, we could suggest that teachers in country A were engaging more frequently in different kinds of activities than their counterparts in country B. On the other hand, teachers in these two countries may have been very similar in that they placed the same kind of relative emphasis on all three orientations of teacher practice. We could even argue that it is more meaningful to compare the profile of importance of the three scores than the absolute values of those scores, given that interpretation of what is "very often" may differ across systems.

Figure 5.4 Radar diagrams for comparisons of pedagogical orientations across indicator sets and systems



In addition to comparing profiles of scores across systems, we also compared the profile of teacher-practice and student-practice scores within the same system. For student practices as reported by teachers in country A, we can see from Figure 5.4 that the mean score is highest for the traditionally important orientation (2.0) and lowest for connectedness (1.4), which is very different from the equal emphasis on all three orientations for mean teacher-practice scores. The lifelong-learning and connectedness scores for student practices reported by teachers in country B are equally highest (1.8) and lowest on the traditionally important orientation, although the scores for the three teacher-practice orientations are the same as in country A. Hence, we can conclude from Figure 5.4 that, as reported by the respective teachers, students in country B were more likely to engage in 21st-century-oriented learning activities than in traditionally important ones, whereas the situation is the opposite in country A, despite the pedagogical orientations of the teachers' practices being very similar in these two countries.

Figure 5.5 uses the same format of representation as in Figure 5.4 to present the profiles of teacher-practice and student-practice orientation scores for mathematics teachers in the SITES 2006 participating systems corresponding results for mathematics teachers can be found in Figure W5.5M in http://www.sites2006.net/appendix. It can be seen that in nearly all systems, the student-practice scores are lower than the corresponding teacher-practice scores and that these two sets of indicators have different profiles. Compared with teacher practices, student practices tend to have relatively higher scores for the traditionally important orientation and relatively lower scores for the connectedness orientation.

5.2 ICT-using pedagogical orientations of mathematics teachers and science teachers

The previous section focused on teachers' pedagogical orientations as reflected in their overall espoused curriculum goals, teacher practices, and student practices through the core indicators. Another important question that the SITES surveys have explored is the impact of ICT-use on pedagogical practice. Thus, *do pedagogical orientations in mathematics and science classrooms differ whether or not ICT is used?* For answers to this question, teachers were asked if ICT was used for different teacher-related and student-related practices. In this section, we examine the pedagogical orientations of mathematics' and science teachers' ICT-using practices and compare them with their overall pedagogical orientations.

5.2.1 ICT-using teacher practices

Box 5.2 in Section 5.1.2 grouped the teacher practices included in the teacher questionnaire according to their pedagogical orientations. In addition to being asked how often they adopted each of these listed teacher practices, teachers were asked if they had used ICT for conducting those practices. Computation of the mean percentage of teachers who gave "yes" responses to items within each pedagogical orientation subscale allowed us to give the respective ICT-using teacher-practice scores. Figure 5.6 shows the mean ICT-using teacher-practice indicators for the three orientations (*traditionally important*, *lifelong learning*, and *connectedness*) as reported by the mathematics and the science teachers in the participating systems.

Figure 5.5 Radar diagrams showing the teacher-practice and student-practice orientation scores for science teachers in each of the participating systems

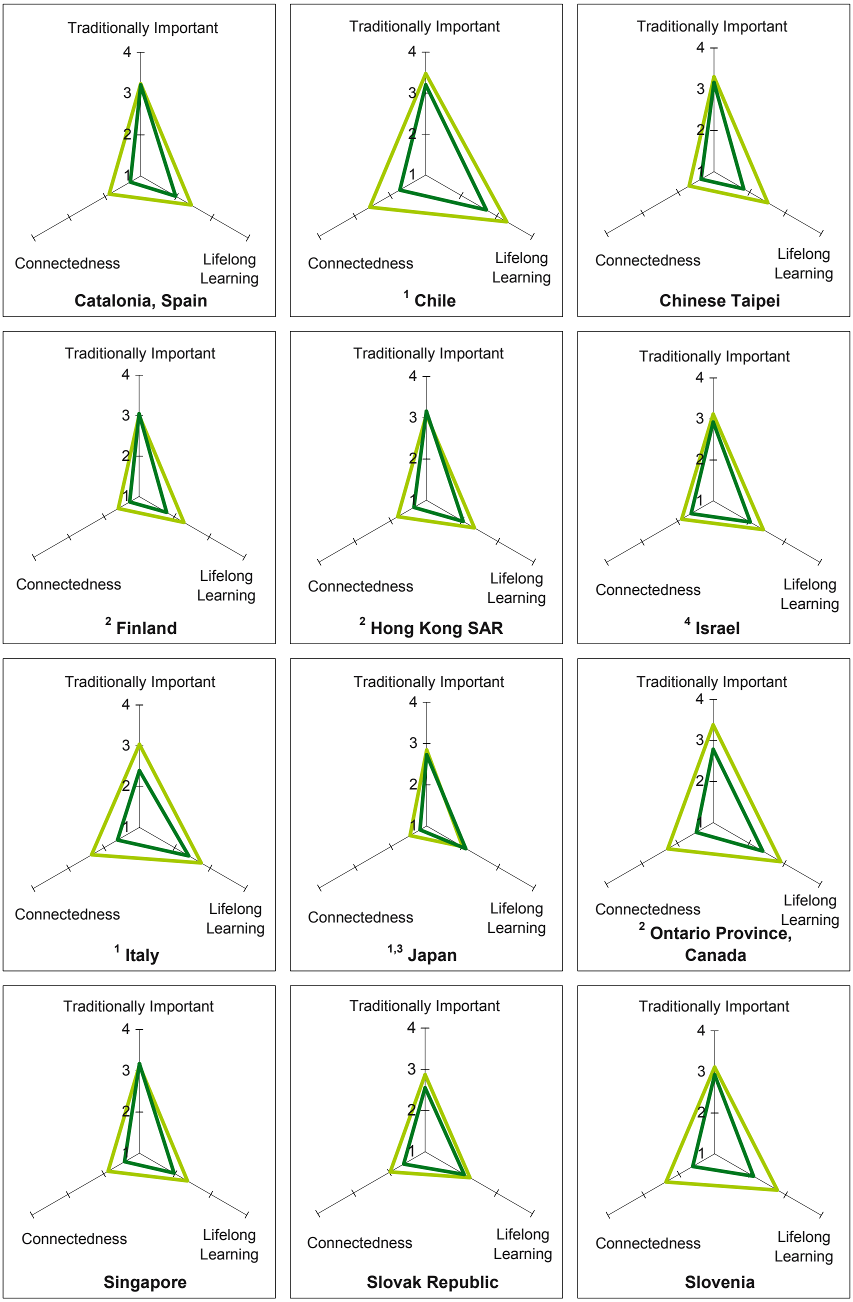
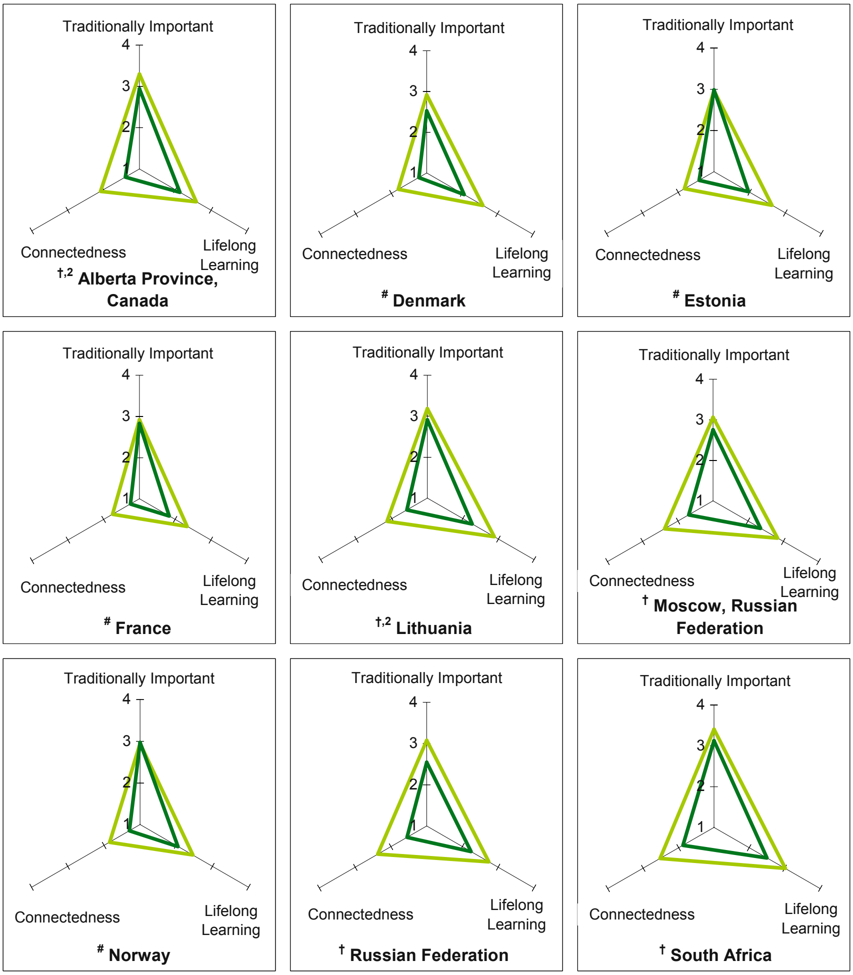
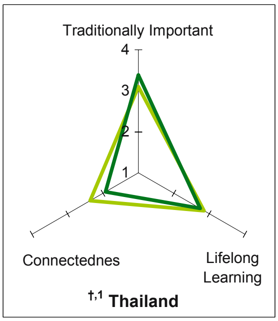


Figure 5.5 Radar diagrams showing the teacher-practice and student-practice orientation scores for science teachers in each of the participating systems (Continued)





Notes:
Overall scores were on a four-point Likert scale
#School participation rate after including replacement schools is below 70%
†International procedures for target-class selection were not followed in all schools
[1]School participation rate before including replacement schools is below 85%
[2]School participation rate after including replacement schools is below 85%
[3]Teacher participation data were collected after survey administration
[4]Nationally defined population covers less than 90% of the nationally desired population.

Comparison of the overall teacher-practice orientations presented in Figure 5.2 reveals one recognizable similarity in the profile of ICT-using teacher-practice orientations: the highest ICT-using teacher-practice indicator is still the traditionally important orientation for most systems. The one prominent exception is Finland, where the mean ICT-using teacher-practice indicator is highest for the connectedness orientation, as reported by both sets of teachers. Despite these similarities, much larger differences were evident across systems in the mean scores for ICT-using teacher-practice orientations than in the mean scores for overall teacher-practice orientations. And although the mean ICT-using lifelong-learning orientation indicators were generally higher than the corresponding indicators for the connectedness orientation, greater variability was apparent in the difference between these two indicators across different systems.

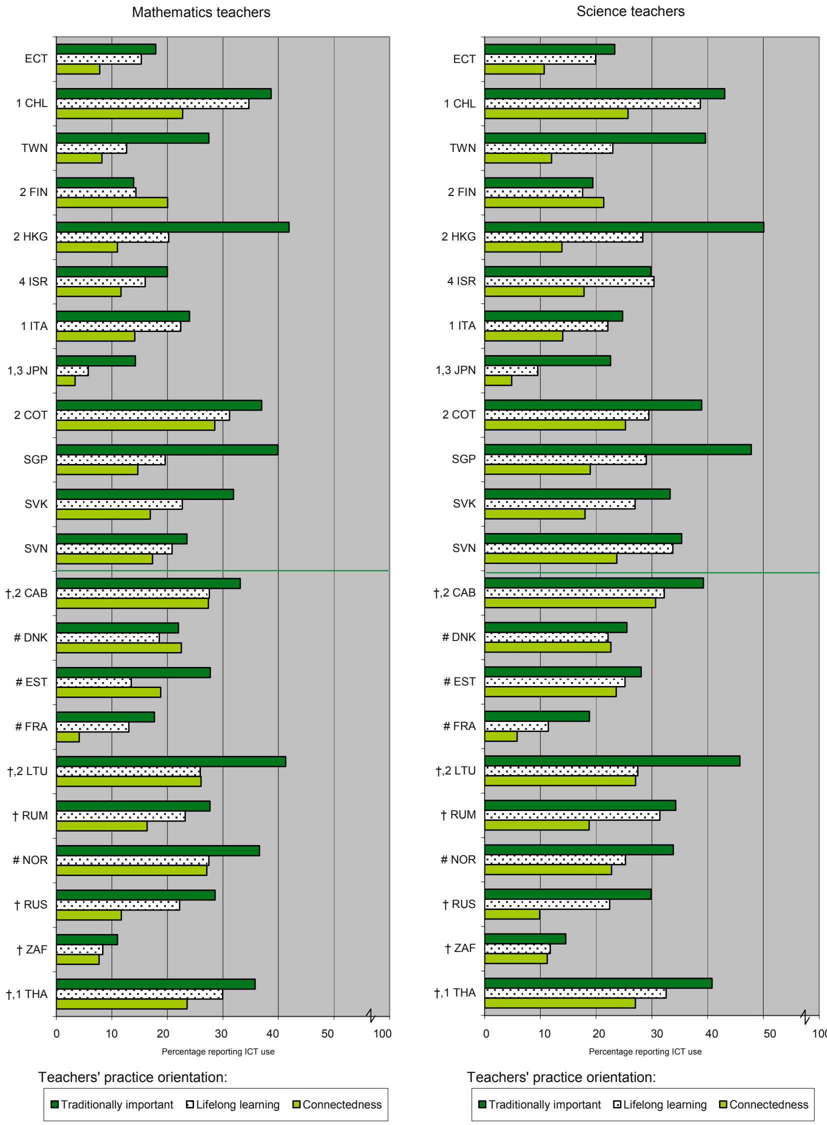
By comparing the results for the mathematics and the science teachers presented in Figure 5.6, we can see that the overall patterns of ICT-use for these two teacher populations within the same system are much more similar than the patterns of use for teachers of the same subject across different systems. However, we can also observe a consistent trend in nearly all of the participating systems: the ICT-using teacher-practice indicator scores are generally higher for science teachers compared to the corresponding indicators for mathematics teachers within the same system for all three teacher-practice orientations. This trend suggests that more science teachers than mathematics teachers were endeavoring to integrate ICT into their pedagogical practices in all three orientations.

5.2.2 ICT-using student practices

As noted earlier, the student-practice indicators are arguably the most important among the three sets of core indicators on pedagogical orientations because it is ultimately students' learning experiences that potentially have the highest impact on students' learning outcomes. The analyses reported in Section 5.1.3 indicated greater variations across systems in the student-practice scores as compared to the teacher-practice scores for each of the three pedagogical orientations.

Figure 5.7 presents the clustered bar graphs of the mean ICT-using student-practice indicator scores for the three orientations. Similar to the pattern we observed in relation to ICT-using teacher practices and as revealed by comparison of Figures 5.3 and 5.7, much larger differences

Figure 5.6 Mean ICT-using teacher-practice orientations reported by mathematics teachers and science teachers



Notes:

#School participation rate after including replacement schools is below 70%

†International procedures for target-class selection were not followed in all schools

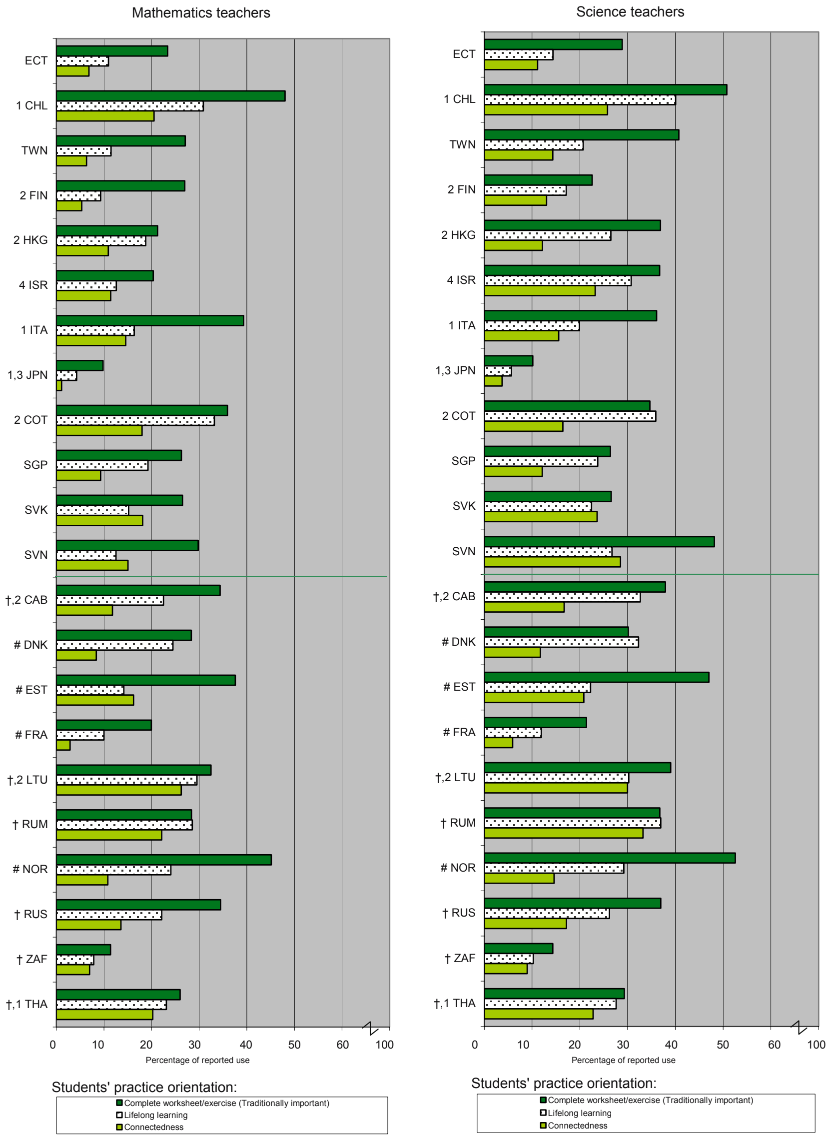
1 School participation rate before including replacement schools is below 85%

2 School participation rate after including replacement schools is below 85%

3 Teacher participation data were collected after survey administration

4 Nationally defined population covers less than 90% of the nationally desired population.

Figure 5.7 Mean ICT-using student-practice orientations reported by mathematics teachers and science teachers



Notes:
#School participation rate after including replacement schools is below 70%
†International procedures for target-class selection were not followed in all schools
[1]School participation rate before including replacement schools is below 85%
[2]School participation rate after including replacement schools is below 85%
[3]Teacher participation data were collected after survey administration
[4]Nationally defined population covers less than 90% of the nationally desired population.

emerged across systems in the extent of ICT-use in student practices compared to the general adoption of student practices. Again, we can see that the ICT-using student-practice indicators are generally highest for the traditionally important orientation. However, there are much greater variations across systems as well as exceptions. For example, the highest score among the three ICT-using student-practice indicator scores is that for lifelong-learning reported by science teachers in Ontario.

Comparison of the scores of the mathematics teachers and the science teachers showed ICT-using student-practice indicators were more similar within the same system than within the same subject across systems. Furthermore, and similar to the observation reported in 5.2.1, science teachers were more likely to use ICT in student practices than were their mathematics counterparts within the same system.

As reported in Section 5.1.4, the findings also showed that students played a more passive role (i.e., were less actively engaged) than teachers as far as overall pedagogical practices were concerned. But would this observation still hold in situations where ICT was being used? Comparison of the results in Figures 5.6 and 5.7 shows that, overall, the percentages of ICT-use in student practices were comparable to the corresponding percentages in teacher practices. While it is not clear how far the ICT-using practices were influencing students' engagement in pedagogical activities overall, it is still heartening to note that the students had opportunities similar to those of their teachers to use ICT in pedagogical situations. The next two sections provide a more detailed comparison between overall and ICT-using pedagogical practices.

5.2.3 Comparing overall and ICT-using teacher-practice orientations

Similar to the format used in Figure 5.5, Figure 5.8 presents, for each of the participating systems, the overall and ICT-using teacher practices for science teachers on the same radar diagram (the corresponding figure for mathematics teachers can be found in Figure W.5.8M at http://www.sites2006.net/appendix. This representation allows us to visualize more clearly within-system differences between these two kinds of practices as well as their similarities and differences across systems. Several prominent observations can be made from a careful inspection of Figure 5.8. First, the overall score profiles for the three teacher-practice orientations are rather similar across systems; that is, the outer triangles show similar shapes, with the longest vertex on the

Figure 5.8 Radar diagrams on the overall and ICT-using teacher practices for science teachers in each of the participating systems

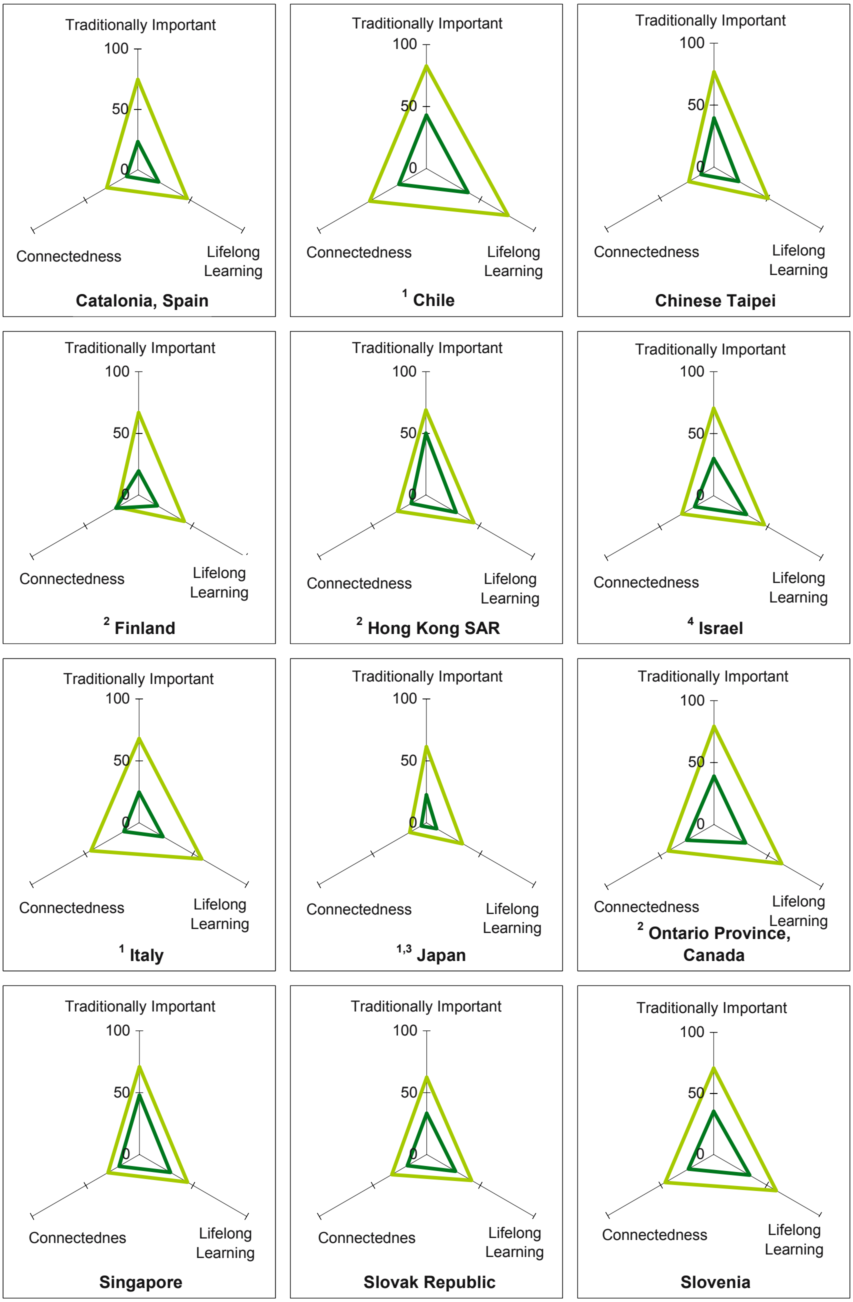
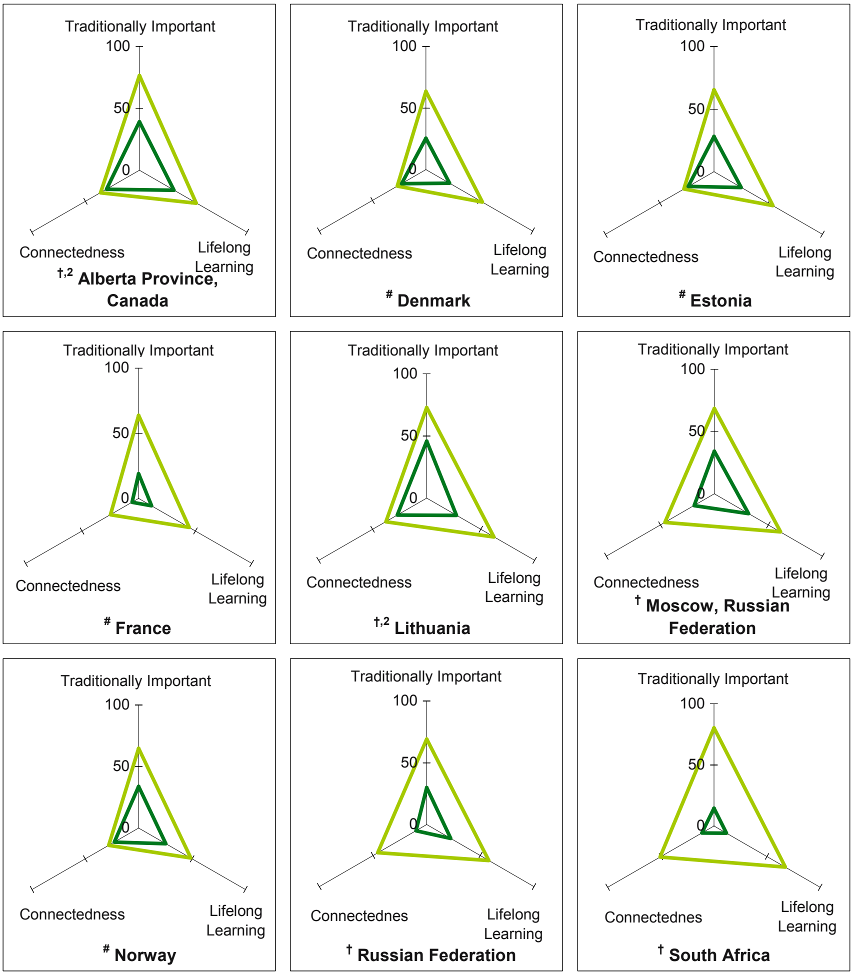
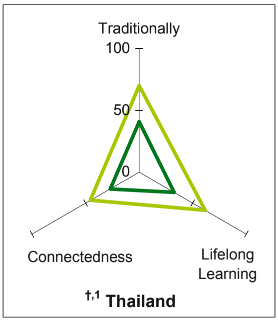
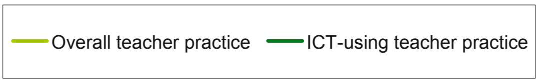


Figure 5.8 Radar diagrams on the overall and ICT-using teacher practices for science teachers in each of the participating systems (Continued)







Notes:

Formula for conversion of overall teacher practice score in 4-point Likert scale (s) to percentage (p): p=(s-1)/3*100

Overall scores were on a four-point Likert scale

[#]School participation rate after including replacement schools is below 70%

[†]International procedures for target-class selection were not followed in all schools

[1]School participation rate before including replacement schools is below 85%

[2]School participation rate after including replacement schools is below 85%

[3]Teacher participation data were collected after survey administration

[4]Nationally defined population covers less than 90% of the nationally desired population.

traditionally important axis and shortest on the connectedness axis. However, and secondly, there are more variations in the shapes of the inner triangles formed by the ICT-using pedagogical-practice indicator scores (these triangles are smaller because they comprise a subset of the overall pedagogical practices). This pattern indicates greater diversity across systems in the profiles of ICT-using teacher-practice orientations.

For about half of the systems, among them Chile, Singapore, and Slovenia, both the outer and inner triangles have very similar shapes, indicating that, for these countries, the ICT-using teacher practices had much the same profiles of emphasis for the three orientations as the overall teacher practices. Most systems for which the two triangles are dissimilar showed a stronger 21st-century orientation in their ICT-using teacher practices. For example, the ICT-using teacher practices in Finland showed a much stronger emphasis on connectedness than on the other two orientations, indicating that Finnish teachers were taking advantage of ICT to connect their classrooms to experts, professional peers, and other classrooms. One exception in this regard is Hong Kong. Its ICT-using teacher practices showed a slightly stronger traditionally important orientation than its overall profile of orientations.

Another noteworthy observation in regard to Figure 5.8 is that the systems cluster together differently in terms of their teacher-practice orientation profiles, with the difference dependent on whether the overall practices or the ICT-using practices only are considered. For example, the outer triangle in Finland's radar diagram is very similar in shape to that for Hong Kong, Japan, and Singapore, but its inner triangle is totally different in shape from the inner triangles for these three other systems. One implication from these observations is that ICT was influencing teacher-practice orientations in some systems and that, overall, the use of ICT appeared to be most favoring 21st-century practices, particularly those falling within the connectedness orientation.

The stronger similarity across systems in overall teacher practice indicates larger differences across systems in terms of how they had integrated ICT into the school curriculum. This consideration further suggests that integrating ICT into the curriculum can be leveraged as a mechanism for bringing about pedagogical change and innovation. If we expect ICT-using teacher practices to become more prevalent in schools in future, then policymakers and educators in the participating systems may need to examine the profile of orientations in ICT-using practices identified in this study in order to determine if the profile for their own system reflects the desired policy priority for pedagogical ICT-use and for the school curriculum overall.

5.2.4 Comparing overall and ICT-using student-practice orientations

Figure 5.9 presents the radar diagrams for overall and ICT-using student-practice orientations as reported by science teachers (the corresponding results for mathematics teachers can be found in Figure W5.9M in http://www.sites2006.net/appendix. A comparison of this figure with Figure 5.8 clearly shows the differences between the two triangles within each system for this set of radar diagrams. In fact, there is not one system where the two triangles are similar, a pattern which indicates that, in countries around the world, adoption of ICT has produced more changes in student practices than in teacher practices. In many of the systems, such as Catalonia, Chile, Ontario, the Slovak Republic, and Slovenia, the use of ICT has focused more strongly on the connectedness orientation. This same pattern is evident even in Japan despite the country's low levels of ICT-adoption in all three orientations.

In several other systems, we can see that both the connectedness and the lifelong-learning orientations assumed a more important place within the ICT-using student-practice orientations than within overall student practice. Among these systems are Hong Kong, Israel, and Singapore. Italy was the only system to place less emphasis on the lifelong orientation than on the traditionally important orientation in its ICT-using student practices.

The SITES 2006 results thus indicate that use of ICT in student practices is having a more pervasive impact on the profile of pedagogical practice orientations than is its use in teacher practices. This perspective on the impact of ICT on student practice added to the picture we obtained when examining the extent to which systems had adopted ICT in these two kinds of practice. Across systems, it seems that despite opportunities for students to use ICT in their learning activities remaining low, student practices were having a strong or potentially strong impact on changing the pedagogical practice orientation in classrooms. Further, these changes appear to have been primarily increasing the relative importance of 21st-century orientations, particularly connectedness.

An implication of these findings is that the adoption of ICT into teaching and learning activities can be used positively as an opportunity

Figure 5.9 Radar diagrams on the overall and ICT-using student practices for science teachers in each of the participating systems

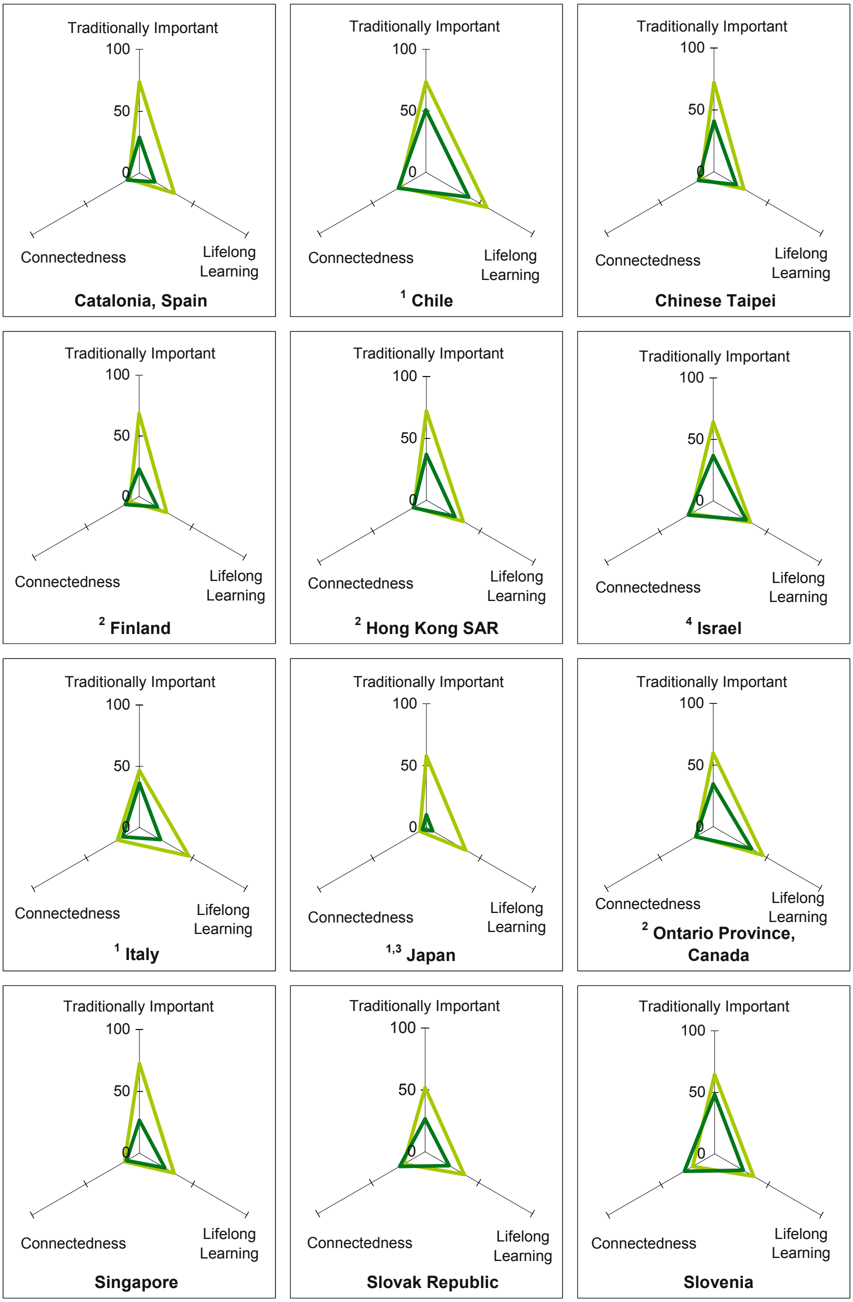
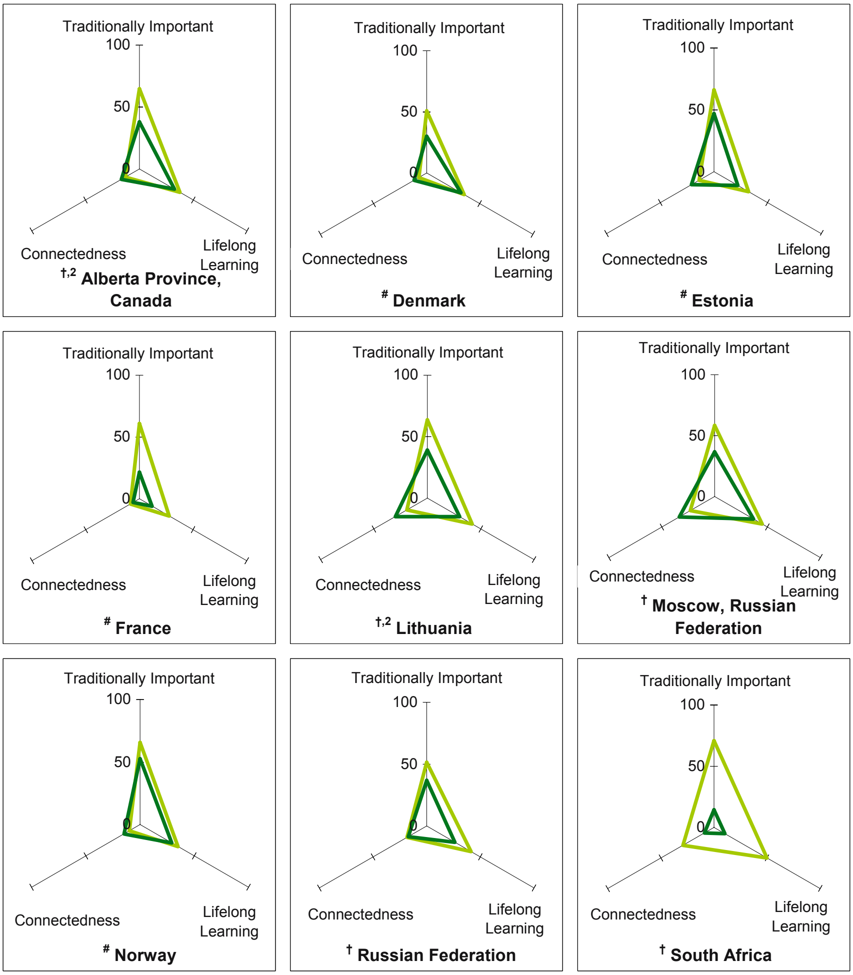
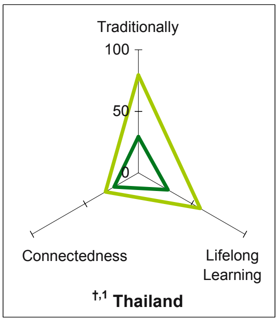
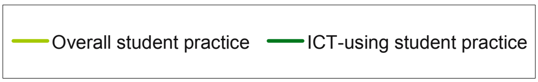


Figure 5.9 Radar diagrams on the overall and ICT-using student practices for science teachers in each of the participating systems (Continued)







Notes:

Formula for conversion of overall teacher practice score in 4-point Likert scale (s) to percentage (p): p=(s-1)/3*100

Overall scores were on a four-point Likert scale

[#]School participation rate after including replacement schools is below 70%

[†]International procedures for target-class selection were not followed in all schools

[1]School participation rate before including replacement schools is below 85%

[2]School participation rate after including replacement schools is below 85%

[3]Teacher participation data were collected after survey administration

[4]Nationally defined population covers less than 90% of the nationally desired population.

to bring about the kind of pedagogical reform that is suited to the demands of the 21st century. These findings also have important implications for education policy and strategies related to teacher professional development, particularly those associated with promoting pedagogical change and innovation.

5.3 Organization of pedagogical activities, learning resources, assessment practices, and ICT-use

In addition to identifying core indicators of pedagogical orientations embedded within espoused curriculum goals, teacher practices, and student practices, the teacher survey elicited, in order to provide supplementary indicators, responses related to other aspects of pedagogical practice. These included the kinds of pedagogical activities organized, whether teachers and their students were separated in space and/or time for different kinds of teaching and learning activities, the resources used by teachers and students, and the assessment methods adopted. This section reports on findings related to these aspects of pedagogical practices and the contribution of ICT to some of them.

5.3.1 Types of pedagogical activities

The question on teacher practices sought information about the roles played by teachers in their pedagogical interactions, such as monitoring students, giving feedback, and assessing students. However, such practices often take place in the context of activities that have identifiable structures and formats, such as field trips and experiments. Learning how to organize different types of teaching and learning activities is an important component in pre-service teacher education programs, and is often referred to as teaching methods. In the survey, teachers were asked to indicate how often the scheduled learning time of their target classes was used for the following activities:

A Extended projects (two weeks or longer)
B Short-task projects
C Product creation (e.g., making a model or a report)
D Self-accessed courses and/or learning activities
E Scientific investigations (open-ended)
F Field-study activities
G Teacher lectures

H Exercises to allow practice of skills and procedures
I Laboratory experiments with clear instructions and well-defined outcomes
J Discovering mathematics principles and concepts
K Studying natural phenomena through simulations
L Looking up ideas and information
M Processing and analyzing data.

G (*teacher lectures*) and H (*exercises to allow practice of skills and procedures*) are activities associated with traditionally important pedagogical roles of teachers and learners and are very common in classrooms. The inclusion of these two items made it easy to compare the likelihood of adoption of these pedagogical activities with the others.

Tables 5.1a and 5.1b present the mean frequencies of adoption for the 13 types of pedagogical activities cited above and as reported by the mathematics and the science teachers on a four-point Likert scale (1=never, 2=sometimes, 3=often, 4=nearly always). The pedagogical activities that the mathematics teachers most frequently adopted were *exercises to allow practice of skills/procedures* (system means ranging from 2.53 to 3.48), *teacher lectures* (means from 1.84 to 3.63), and *discovering mathematics principles and concepts* (means from 1.80 to 3.23). The pedagogical activities most frequently adopted by science teachers were *teacher lectures* (means from 1.94 to 3.60), *exercises to allow practice of skills/procedures* (means from 2.18 to 3.16), and *laboratory experiments with clear instructions and well-defined outcomes* (means from 1.96 to 3.34).

The three pedagogical activities least frequently adopted by mathematics teachers were *field study activities* (means from 1.12 to 2.10), *studying natural phenomena through simulations* (means from 1.24 to 2.23), and *laboratory experiments with clear instructions and well-defined outcomes* (means from 1.18 to 2.18). The science teachers also gave their lowest ranking to *field study activities* science teachers (means from 1.45 to 2.41). *Extended projects* (means from 1.41 to 2.41) and *discovering mathematics principles and concepts* (means from 1.45 to 2.52) received the second and third lowest rankings from these teachers.

The above observations and the results presented in Tables 5.1a and 5.1b indicate that, unlike the profiles of the core indicators for pedagogical-practice orientations, which were very similar for science teachers and mathematics teachers within the same system, the relative frequency of adoption of many of the pedagogical activities differed

Table 5.1a Listing of how often, on average, the mathematics teachers of each system practiced different methods of organizing teaching and learning activities

	Education system	Extended projects	Short-task projects	Product creation (e.g. making model/report)	Self-accessed courses/ learning activities	Scientific investigations (open-ended)	Field study activities	Teacher lectures	Exercises to practise skills/ procedures	Lab experiments w/ clear instructions & well-defined outcomes	Discovering math principles & concepts	Studying natural phenomoena through simulations	Looking up ideas & info	Processing and Analyzing Data
	Catalonia, Spain	1.8 (0.04)	2.3 (0.04)	1.7 (0.04)	1.8 (0.04)	1.4 (0.03)	1.6 (0.03)	3.2 (0.04)	3.2 (0.04)	1.4 (0.03)	2.4 (0.03)	1.4 (0.03)	2.1 (0.03)	2.1 (0.03)
1	Chile	2.1 (0.04)	2.4 (0.04)	2.5 (0.04)	2.3 (0.04)	1.8 (0.04)	1.7 (0.04)	3.0 (0.04)	3.3 (0.04)	1.9 (0.05)	3.1 (0.04)	1.9 (0.05)	3.1 (0.04)	2.9 (0.04)
	Chinese Taipei	1.3 (0.02)	1.5 (0.02)	1.6 (0.02)	2.1 (0.03)	1.6 (0.03)	1.5 (0.02)	3.6 (0.02)	3.0 (0.03)	2.1 (0.03)	2.9 (0.03)	1.6 (0.03)	2.1 (0.03)	2.1 (0.03)
2	Finland	1.2 (0.02)	1.7 (0.02)	1.4 (0.02)	1.3 (0.02)	1.3 (0.03)	1.2 (0.02)	2.5 (0.04)	3.0 (0.03)	1.4 (0.03)	3.0 (0.03)	1.2 (0.02)	2.5 (0.04)	1.8 (0.04)
2	Hong Kong SAR	1.5 (0.02)	1.9 (0.03)	1.6 (0.03)	2.0 (0.03)	1.6 (0.02)	1.3 (0.02)	3.6 (0.03)	3.5 (0.03)	2.0 (0.04)	2.8 (0.04)	1.5 (0.03)	2.0 (0.03)	2.2 (0.04)
4	Israel	1.4 (0.02)	2.1 (0.03)	1.5 (0.03)	1.9 (0.03)	1.7 (0.03)	1.4 (0.03)	2.7 (0.03)	3.2 (0.03)	1.3 (0.03)	3.1 (0.04)	1.5 (0.03)	2.1 (0.03)	2.3 (0.03)
1	Italy	2.2 (0.03)	2.4 (0.03)	1.9 (0.03)	1.5 (0.03)	1.9 (0.04)	1.8 (0.04)	3.3 (0.04)	3.1 (0.04)	1.8 (0.04)	2.6 (0.04)	1.8 (0.04)	2.5 (0.04)	2.4 (0.04)
1, 3	Japan	1.7 (0.04)	2.7 (0.04)	1.4 (0.03)	1.8 (0.04)	1.1 (0.02)	1.1 (0.02)	3.1 (0.05)	2.8 (0.04)	1.3 (0.03)	3.0 (0.03)	1.4 (0.02)	1.8 (0.04)	1.6 (0.03)
2	Ontario Province, Canada	2.2 (0.04)	2.9 (0.03)	2.4 (0.04)	2.0 (0.04)	2.0 (0.03)	1.6 (0.03)	2.6 (0.04)	3.2 (0.03)	1.9 (0.05)	3.1 (0.04)	1.7 (0.03)	2.8 (0.04)	2.7 (0.04)
	Singapore	1.5 (0.03)	1.9 (0.04)	1.5 (0.03)	2.0 (0.04)	1.4 (0.03)	1.3 (0.02)	2.9 (0.05)	3.3 (0.04)	1.3 (0.03)	2.5 (0.04)	1.4 (0.03)	2.1 (0.03)	2.1 (0.04)
	Slovak Republic	1.3 (0.02)	1.8 (0.03)	1.9 (0.03)	2.2 (0.03)	1.3 (0.02)	1.3 (0.02)	3.2 (0.04)	3.3 (0.04)	1.3 (0.03)	2.6 (0.04)	1.5 (0.03)	2.3 (0.03)	2.2 (0.03)
	Slovenia	1.4 (0.02)	1.9 (0.03)	2.0 (0.02)	1.6 (0.03)	1.5 (0.02)	1.3 (0.02)	2.6 (0.04)	2.8 (0.03)	1.2 (0.02)	3.2 (0.03)	1.4 (0.03)	2.5 (0.03)	2.4 (0.03)
†, 2	Alberta Province, Canada	1.6 (0.04)	2.7 (0.04)	1.9 (0.04)	1.8 (0.04)	1.6 (0.04)	1.4 (0.03)	2.9 (0.05)	3.3 (0.05)	1.6 (0.04)	3.0 (0.04)	1.6 (0.03)	2.2 (0.04)	2.5 (0.04)
#	Denmark	1.9 (0.04)	2.4 (0.03)	2.1 (0.04)	2.4 (0.04)	1.8 (0.04)	1.8 (0.03)	2.9 (0.03)	3.0 (0.03)	1.7 (0.04)	3.0 (0.04)	1.5 (0.03)	2.3 (0.04)	2.3 (0.03)
#	Estonia	1.3 (0.03)	1.7 (0.04)	1.5 (0.03)	2.1 (0.05)	1.2 (0.03)	1.4 (0.04)	2.4 (0.05)	3.4 (0.05)	1.6 (0.05)	2.3 (0.05)	1.2 (0.04)	2.2 (0.05)	1.9 (0.05)
#	France	1.4 (0.03)	2.5 (0.05)	1.5 (0.03)	2.5 (0.04)	1.8 (0.04)	1.1 (0.02)	2.3 (0.06)	3.2 (0.04)	1.2 (0.03)	2.9 (0.04)	1.3 (0.03)	2.1 (0.04)	2.2 (0.04)
†, 2	Lithuania	1.8 (0.03)	2.3 (0.03)	2.3 (0.04)	2.0 (0.04)	1.5 (0.04)	1.8 (0.04)	1.8 (0.04)	2.5 (0.05)	1.5 (0.04)	2.1 (0.04)	1.3 (0.03)	2.4 (0.04)	2.5 (0.04)
†	Moscow, Russian Federation	1.8 (0.04)	2.1 (0.03)	2.0 (0.03)	2.4 (0.03)	1.9 (0.03)	1.2 (0.02)	2.5 (0.03)	3.2 (0.03)	1.9 (0.04)	2.0 (0.03)	1.6 (0.03)	2.3 (0.03)	2.6 (0.04)
#	Norway	1.7 (0.04)	2.1 (0.03)	1.8 (0.05)	1.9 (0.05)	1.7 (0.05)	1.6 (0.04)	2.8 (0.03)	2.7 (0.04)	1.8 (0.05)	2.1 (0.03)	1.4 (0.04)	2.2 (0.04)	1.9 (0.04)
†	Russian Federation	1.6 (0.04)	2.0 (0.04)	1.9 (0.05)	2.4 (0.05)	1.9 (0.04)	1.3 (0.03)	2.4 (0.03)	3.2 (0.03)	2.1 (0.05)	1.8 (0.04)	1.5 (0.04)	2.2 (0.04)	2.4 (0.05)
†	South Africa	2.2 (0.04)	2.7 (0.04)	2.3 (0.04)	2.6 (0.05)	2.2 (0.04)	2.0 (0.04)	2.9 (0.05)	3.1 (0.04)	1.7 (0.05)	3.0 (0.04)	2.2 (0.04)	2.8 (0.04)	2.6 (0.05)
†, 1	Thailand	1.9 (0.03)	2.3 (0.04)	2.5 (0.04)	2.7 (0.04)	2.2 (0.05)	2.1 (0.04)	3.2 (0.04)	3.2 (0.04)	2.2 (0.05)	2.7 (0.04)	2.1 (0.04)	2.3 (0.04)	2.5 (0.04)

Notes:

Value labels for the response categories: 1=never, 2=sometimes, 3=often, 4=nearly always

[#] School participation rate after including replacement schools is below 70%

[†] International procedures for target-class selection was not followed in all schools

[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Teacher participation data were collected after survey administration

[4] Nationally defined population covers less than 90% of the nationally desired population.

Table 5.1b Listing of how often, on average, the science teachers of each system practiced different methods of organizing teaching and learning activities

Education system	Extended projects	Short-task projects	Product creation (e.g. making model/report)	Self-accessed courses/ learning activities	Scientific investigations (open-ended)	Field study activities	Teacher lectures	Exercises to practise skills/ procedures	Lab experiments w/ clear instructions & well-defined outcomes	Discovering math principles & concepts	Studying natural phenomoena through simulations	Looking up ideas & info	Processing and Analyzing Data
Catalonia, Spain	2.0 (0.04)	2.5 (0.03)	2.3 (0.04)	1.9 (0.04)	2.0 (0.03)	2.0 (0.03)	3.2 (0.04)	3.0 (0.04)	2.7 (0.04)	1.9 (0.04)	2.0 (0.04)	2.5 (0.03)	2.1 (0.03)
[1] Chile	2.4 (0.04)	2.7 (0.04)	2.8 (0.05)	2.4 (0.05)	2.2 (0.05)	1.9 (0.04)	2.9 (0.04)	3.0 (0.04)	2.6 (0.05)	2.3 (0.05)	2.5 (0.05)	3.3 (0.04)	2.9 (0.04)
Chinese Taipei	1.4 (0.03)	1.6 (0.02)	1.8 (0.02)	2.0 (0.03)	1.8 (0.03)	1.6 (0.02)	3.5 (0.03)	2.7 (0.03)	2.9 (0.03)	2.2 (0.03)	2.2 (0.03)	2.3 (0.02)	2.1 (0.03)
[2] Finland	1.5 (0.03)	2.1 (0.02)	1.7 (0.04)	1.4 (0.03)	1.6 (0.03)	1.5 (0.03)	2.6 (0.04)	2.7 (0.03)	2.7 (0.04)	1.9 (0.04)	1.7 (0.03)	2.5 (0.03)	1.9 (0.03)
[2] Hong Kong SAR	1.7 (0.04)	2.1 (0.03)	1.9 (0.03)	2.0 (0.02)	2.1 (0.03)	1.5 (0.03)	3.6 (0.03)	2.9 (0.04)	3.3 (0.03)	1.8 (0.03)	2.1 (0.04)	2.3 (0.03)	2.2 (0.03)
[4] Israel	2.0 (0.04)	2.5 (0.03)	2.3 (0.03)	2.0 (0.03)	2.3 (0.04)	1.7 (0.03)	2.9 (0.03)	2.9 (0.04)	2.9 (0.04)	2.0 (0.04)	2.0 (0.03)	2.7 (0.03)	2.5 (0.04)
[1] Italy	2.1 (0.03)	2.4 (0.03)	1.9 (0.03)	1.5 (0.03)	1.9 (0.03)	1.8 (0.03)	3.4 (0.03)	2.9 (0.04)	2.0 (0.03)	2.5 (0.04)	1.9 (0.03)	2.6 (0.03)	2.4 (0.03)
[1,3] Japan	1.6 (0.03)	2.5 (0.04)	2.1 (0.03)	1.6 (0.03)	1.8 (0.03)	1.6 (0.03)	3.2 (0.05)	2.4 (0.03)	2.7 (0.03)	2.2 (0.04)	2.0 (0.03)	1.9 (0.03)	2.2 (0.03)
[2] Ontario Province, Canada	2.4 (0.04)	2.9 (0.03)	2.6 (0.04)	1.9 (0.04)	2.4 (0.04)	1.7 (0.04)	2.6 (0.04)	2.9 (0.04)	2.5 (0.04)	2.5 (0.05)	2.0 (0.04)	2.9 (0.04)	2.5 (0.04)
Singapore	1.7 (0.03)	2.0 (0.03)	1.8 (0.03)	1.9 (0.03)	2.0 (0.03)	1.5 (0.03)	3.1 (0.04)	2.8 (0.05)	2.8 (0.04)	1.7 (0.04)	2.0 (0.04)	2.4 (0.04)	2.3 (0.04)
Slovak Republic	1.5 (0.02)	2.1 (0.02)	2.4 (0.02)	2.3 (0.02)	1.4 (0.02)	1.5 (0.02)	3.2 (0.02)	2.9 (0.03)	2.2 (0.03)	1.8 (0.03)	1.9 (0.02)	2.6 (0.03)	2.1 (0.03)
Slovenia	1.7 (0.02)	2.3 (0.02)	2.3 (0.02)	2.0 (0.03)	2.0 (0.03)	1.9 (0.02)	2.6 (0.03)	2.5 (0.02)	2.4 (0.03)	2.0 (0.03)	2.2 (0.03)	2.5 (0.03)	2.4 (0.02)
†,[2] Alberta Province, Canada	2.0 (0.04)	2.8 (0.04)	2.4 (0.04)	1.9 (0.05)	2.4 (0.04)	1.7 (0.03)	2.7 (0.04)	2.8 (0.04)	2.6 (0.04)	2.2 (0.04)	2.1 (0.04)	2.7 (0.04)	2.4 (0.04)
# Denmark	2.3 (0.04)	2.3 (0.03)	2.4 (0.04)	2.4 (0.04)	2.1 (0.03)	1.9 (0.03)	2.9 (0.03)	2.7 (0.03)	2.3 (0.04)	1.9 (0.04)	1.8 (0.03)	2.6 (0.04)	2.3 (0.04)
# Estonia	1.5 (0.03)	2.0 (0.04)	1.5 (0.03)	2.1 (0.04)	1.3 (0.04)	1.6 (0.03)	2.6 (0.04)	3.0 (0.04)	2.2 (0.04)	1.6 (0.03)	1.8 (0.04)	2.5 (0.04)	1.8 (0.04)
# France	1.7 (0.03)	2.6 (0.04)	1.8 (0.03)	2.6 (0.04)	2.4 (0.04)	1.5 (0.03)	2.2 (0.04)	2.9 (0.04)	2.7 (0.04)	1.7 (0.03)	2.1 (0.03)	2.5 (0.03)	2.2 (0.04)
†,[2] Lithuania	1.9 (0.03)	2.4 (0.03)	2.4 (0.03)	2.1 (0.04)	1.5 (0.04)	1.9 (0.03)	1.9 (0.04)	2.5 (0.04)	2.3 (0.04)	1.7 (0.04)	1.8 (0.04)	2.6 (0.04)	2.6 (0.04)
† Moscow, Russian Federation	1.9 (0.02)	2.4 (0.02)	2.2 (0.02)	2.3 (0.02)	2.1 (0.02)	1.4 (0.02)	2.8 (0.02)	3.0 (0.02)	2.8 (0.02)	1.5 (0.02)	2.1 (0.02)	2.6 (0.02)	2.7 (0.02)
# Norway	1.9 (0.04)	2.3 (0.03)	2.3 (0.04)	1.8 (0.04)	2.2 (0.04)	1.9 (0.03)	2.8 (0.04)	2.2 (0.04)	2.6 (0.04)	1.8 (0.04)	1.7 (0.04)	2.4 (0.04)	1.8 (0.04)
† Russian Federation	1.7 (0.03)	2.1 (0.03)	2.0 (0.03)	2.4 (0.03)	2.0 (0.04)	1.6 (0.03)	2.6 (0.02)	3.0 (0.03)	2.7 (0.04)	1.5 (0.03)	1.9 (0.03)	2.4 (0.03)	2.5 (0.04)
† South Africa	2.2 (0.04)	2.7 (0.04)	2.3 (0.04)	2.5 (0.04)	2.4 (0.04)	2.1 (0.04)	2.8 (0.05)	2.8 (0.04)	2.1 (0.04)	2.5 (0.05)	2.4 (0.04)	2.8 (0.04)	2.5 (0.05)
†,[1] Thailand	2.2 (0.04)	2.4 (0.03)	2.6 (0.04)	2.8 (0.04)	2.5 (0.04)	2.4 (0.03)	3.0 (0.04)	3.2 (0.04)	3.1 (0.04)	2.5 (0.04)	2.6 (0.03)	2.6 (0.04)	2.6 (0.04)

Notes:

Value labels for the response categories: 1=never, 2=sometimes, 3=often, 4=nearly always

School participation rate after including replacement schools is below 70%

† International procedures for target-class selection was not followed in all schools

[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Teacher participation data were collected after survey administration

[4] Nationally defined population covers less than 90% of the nationally desired population.

between the two teacher populations. Although the two most frequently adopted activities were the same for both sets of teachers, mathematics teachers made greater use of *exercises to allow practice of skills/procedures* than of *teacher lectures*; the difference in the frequency with which science teachers adopted these two activities was smaller.

We were not surprised to find the majority of the most frequently adopted pedagogical activities were ones that teachers have long practiced, such as *exercises to allow practice of skills/procedures*, *teacher lectures*, *discovering mathematics principles and concepts*, and *laboratory experiments with clear instructions and well-defined outcomes*. Most of the least frequently practiced pedagogical activities were those that had emerged only in recent years and that tend to be promoted as activities conducive to the development of 21st-century abilities, such *as extended projects* and *open-ended scientific investigations*.

The results presented in Tables 5.1a and 5.1b also reveal that, overall, mathematics teachers tended to use a narrower range of pedagogical activities than did science teachers. Six of the 13 pedagogical activities were little used by mathematics teachers in most systems (mean frequencies of use lower than 2.0—i.e., "sometimes"), while science teachers reported these low levels of use for only three activities. However, science teachers appeared to have a wider repertoire in regard to their core pedagogical activities: none of the activities reached a mean system-wide usage level above 3.0 (i.e., "often") in nine systems, while other than in Norway and Lithuania, mathematics teachers registered a system-wide mean frequency of use at 3.0 or above in at least one activity. We could argue that some of the pedagogical activities were more appropriate for teaching science than for teaching mathematics (e.g., *field study activities* and *scientific investigations*). However, the frequencies of use of some of the emerging activities that were more subject-matter "neutral," such as *extended projects*, *product creation*, and *looking up information*, were higher for science teachers than for mathematics teachers in nearly all of the participating systems.

Teachers were also asked to indicate if they used ICT in each of the listed activities they employed with the target class. Unsurprisingly, wide diversities were evident across systems for all of the activities listed. Those that registered the highest mean percentage of ICT-use in most systems were *looking up ideas and information*, *processing and analyzing data*, *short-task projects*, and *extended projects*.

5.3.2 Teachers and students not together in the same place and/or at the same time when learning takes place

In traditional settings, when teaching and learning take place, teachers and students tend to be together in space (most often in the classroom) and time (scheduled class time). The main exception to this situation before the advent of ICT was distance education. ICT-use has the advantage of allowing teaching and learning to take place anytime anywhere, so allowing teachers and students to engage in teaching and learning activities when they are not together in the same physical location and/or not together at the same time. One of our aims in this analysis of the SITES data was to find out, from responses on the teacher questionnaire, to what extent teachers and students were not together in the same place and/or at the same time during planned teaching and learning activities in mathematics and in science at Grade 8. The questionnaire asked teachers to respond to questions on how frequently separation happened during the following four situations:

1. When instructing students in the target class (excluding field trips)—not at the same place with students.
2. When students in the target class participate in planned learning activities—not at the same place.
3. When students in the target class engage in planned learning activities—at different times.
4. When providing feedback to students in the target class—at different times.

Although the first two questions asked specifically about not being at the same place, a negative response implied that the parties involved were together at the same place and the same time. For the other two questions, events happening at the same time were deemed independent of whether these took place in the same location. For example, a teacher giving feedback to students via video-conference may have been separated in space but co-located in time.

While ICT can be used to support and facilitate the above kinds of learning situations, the questions did not ask if ICT was used in those instances. Separation in space can occur within the school grounds without the use of technology. Separation in time can also take place without the use of technology by having more flexible school schedules or by allowing learners and teachers to work at different times as in traditional distance education.

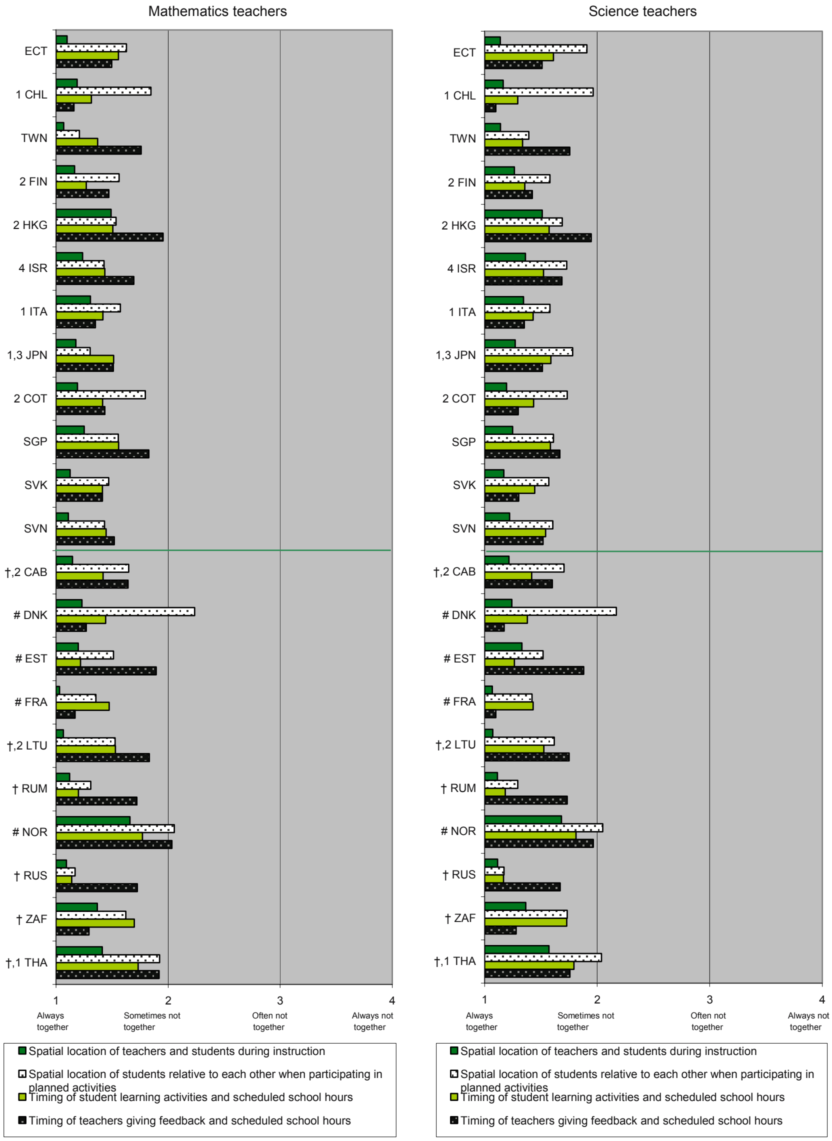
Figure 5.10 presents the four mean "separation" scores for mathematics teachers and science teachers in the participating systems. In general, both teachers and students were mostly together at the same place and the same time. The mean separation scores varied from 1.03 to 2.24 on a four-point Likert scale, with 1 being "always co-located" and 4 being "anytime or anywhere."

The survey results for both the mathematics and the science teachers were similar. In both teacher populations, teachers and students were usually together in space and time *when teachers were giving instructions* (mean scores ranging from 1.03 to 1.66 for mathematics teachers and from 1.07 to 1.68 for science teachers). However, the likelihood of teachers and learners not being together in space was highest when s*tudents participated in planned learning activities* (mean scores ranging from 1.17 to 2.24 for mathematics teachers and from 1.17 to 2.17 for science teachers).

While teachers and students tended to be mostly together in space and time as described earlier, we observed large differences across the systems. The highest probability of separation, reported by both sets of teachers, was evident in Denmark and related to students participating in planned learning activities. On taking all four of the surveyed situations into account, we found that Norway and Thailand showed relatively high and comparable levels of separation across the situations, despite their teachers (both mathematics and science) differing quite substantially in their ICT-use (see Section 5.4 for details about these levels of use). This finding indicates that the separation of teachers and students in space and/or time in the pedagogical process probably depends more on the need for separation than on the availability of ICT. We also noted that separation could include teaching and learning in traditional distance-education mode without the use of ICT. Hence, South Africa reported relatively high levels of separation even though its mathematics teachers and science teachers reported levels of ICT-use that were much lower (at less than 20%) than those of any of the other participating systems (see Figure 5.13).

However, the likelihood of space/time separation in the pedagogical process did not appear to depend solely on the need for distance education. The "separation scores" as reported by the mathematics and the science teachers in Hong Kong were among the top three highest scores in their respective populations even though Hong Kong is very small geographically and students do not attend school or courses in distance mode at Grade 8 level. One possible explanation is

Figure 5.10 Mean frequencies of separation of learners and teachers in space and time in different teaching and learning situations as reported by mathematics teachers and science teachers



Notes:

#School participation rate after including replacement schools is below 70%

†International procedures for target-class selection were not followed in all schools

[1]School participation rate before including replacement schools is below 85%

[2]School participation rate after including replacement schools is below 85%

[3]Teacher participation data were collected after survey administration

[4]Nationally defined population covers less than 90% of the nationally desired population.

that teachers tend to give supplementary instructional materials and exercises for students to work on after school hours. It is not clear how far ICT is used in such situations, but the results in Figures 5.8 and 5.9 indicate a high probability of ICT-use in traditionally important practices in Hong Kong.

5.3.3 Learning resources

Teachers typically use a diversity of resources in their teaching or in their planned students' learning activities. Given that teachers could choose from a wide range of digital tools and resources in addition to the traditional, non-digital ones, we considered it was worthwhile exploring how frequently the teachers in the different systems were actually making use of these resources. Teachers were asked how often they incorporated the use of the following list of tools and resources in their teaching of the target class during the school year in which the survey took place:

A Equipment and hands-on materials (e.g., laboratory equipment, musical instruments, art materials, overhead projectors, slide projectors, electronic calculators)
B Tutorial/exercise software
C General Office suite (e.g., word-processing, database, spreadsheet, presentation software)
D Multimedia production tools (e.g., media capture and editing equipment, drawing programs, webpage/multimedia production tools)
E Data-logging tools (these are the hardware and software designed for conducting computer-supported scientific experiments)
F Simulations/modeling software/digital learning games
G Communication software (e.g., email, chat, discussion forums)
H Digital resources (e.g., portals, dictionaries, encyclopedias)
I Mobile devices (e.g., Personal Digital Assistants (PDAs), cell phones)
J Smart boards/interactive whiteboards
K Learning management systems (e.g., web-based learning environments).

The results of this analysis showed that teachers were more likely to be using conventional *equipment and hands-on materials* than any of the digital tools or resources. The rank ordering in the frequency of use of the different kinds of tools and resources was very similar between the mathematics and the science teachers; the *general Office suite* was the second most frequently used learning resource in both subjects. However, in all the participating systems, science teachers made more frequent use than mathematics teachers of nearly all the different kinds of tools and resources.

Because of space limitations, Table 5.2 presents only the results for the mathematics teachers' use of learning resources (corresponding results for science teachers can be found in Table W5.2S at http://www.sites2006.net/appendix). Here we can see that *digital information resources (*such as *portals, dictionaries, and encyclopedias*) and *tutorial or exercise software* were the next most frequently used types of learning resources and that their relative frequency of use differed from system to system. Moreover, in most of the systems, mathematics teachers were more frequently using *tutorial or exercise software* than *digital information resources (*e.g., *portals, dictionaries, and encyclopedias*); the science teachers' relative frequency of use of these resources was similar.

The results also show that teachers were using general digital resources and tools such as multimedia production tools and communication software more frequently than they were using the more specialized ones such as *data-logging tools* and *simulations/modeling/digital games*. However, teachers were rarely using the more advanced devices, such as *mobile devices* and *smart boards*.

One surprising observation was the low frequency of reported use of learning management systems in both subject areas generally, with the highest mean frequency of only 1.74 reported by mathematics teachers in Singapore and Hong Kong, and 1.82 by science teachers in Chile (responses were solicited on a four-point Likert scale with 1=never and 2=sometimes). This finding contrasts strongly with the high levels of reported use of ICT, which reached 50% or over in most systems (see Section 5.4). Unlike the other resources teachers can use at the individual student or class levels, *learning management systems* tend to be set up at the school level and to have the potential to support and influence ICT-use across all subject areas within the same school. The low level of reported use of these systems suggests that pedagogical use of ICT in schools was largely a teacher-level decision with relatively low institutional influence or support.

Learning management systems can play an important role in allowing teaching and learning activities to take place anytime anywhere. The finding that Norwegian teachers reported relatively high

Table 5.2 Frequency with which mathematics teachers were using different learning resources and tools in the target class

Education system	Equip. or hand-on materials	Tutorial or exercise software	General office suite	Multimedia production tools	Data-logging tools	Simulations, modeling or digi. games	Commun. Software	Digital resources	Mobile devices	Smart board, interactive whiteboard	Learning management system
Catalonia, Spain	2.1 (0.03)	1.9 (0.04)	1.6 (0.03)	1.3 (0.03)	1.3 (0.02)	1.3 (0.02)	1.3 (0.03)	1.6 (0.04)	1.2 (0.02)	1.1 (0.01)	1.4 (0.03)
[1] Chile	2.3 (0.04)	2.0 (0.04)	2.2 (0.04)	1.9 (0.04)	1.9 (0.04)	1.9 (0.04)	1.9 (0.05)	2.3 (0.05)	1.6 (0.04)	1.3 (0.03)	1.7 (0.04)
Chinese Taipei	1.9 (0.02)	1.7 (0.03)	2.3 (0.05)	1.8 (0.03)	1.9 (0.04)	1.4 (0.02)	1.7 (0.03)	1.8 (0.03)	1.4 (0.03)	1.1 (0.02)	1.3 (0.02)
[2] Finland	3.0 (0.04)	1.8 (0.03)	1.6 (0.03)	1.2 (0.02)	1.4 (0.03)	1.3 (0.03)	1.3 (0.03)	1.3 (0.03)	1.2 (0.02)	1.0 (0.01)	1.2 (0.03)
[2] Hong Kong SAR	2.5 (0.04)	2.2 (0.04)	2.7 (0.04)	2.0 (0.04)	1.4 (0.03)	1.6 (0.03)	2.0 (0.03)	1.9 (0.03)	1.4 (0.03)	1.2 (0.02)	1.7 (0.04)
[4] Israel	2.0 (0.03)	1.6 (0.03)	1.6 (0.03)	1.3 (0.02)	1.6 (0.03)	1.3 (0.02)	1.5 (0.03)	1.4 (0.03)	1.5 (0.03)	1.1 (0.02)	1.4 (0.03)
[1] Italy	2.3 (0.03)	1.6 (0.03)	1.8 (0.04)	1.4 (0.03)	1.6 (0.03)	1.4 (0.02)	1.3 (0.03)	1.8 (0.03)	1.3 (0.03)	1.1 (0.02)	1.2 (0.03)
[1, 3] Japan	1.7 (0.03)	1.3 (0.02)	1.5 (0.04)	1.2 (0.02)	1.1 (0.01)	1.2 (0.02)	1.1 (0.01)	1.1 (0.02)	1.0 (0.01)	1.1 (0.02)	1.4 (0.03)
[2] Ontario Province, Canada	3.1 (0.03)	1.9 (0.04)	2.6 (0.04)	1.9 (0.04)	1.6 (0.03)	1.7 (0.03)	1.5 (0.05)	2.0 (0.04)	1.1 (0.02)	1.3 (0.03)	1.5 (0.04)
Singapore	2.7 (0.04)	2.1 (0.05)	2.3 (0.04)	1.8 (0.04)	1.2 (0.03)	1.5 (0.04)	1.6 (0.04)	1.4 (0.03)	1.3 (0.04)	1.3 (0.04)	1.7 (0.03)
Slovak Republic	2.5 (0.03)	1.4 (0.03)	1.7 (0.03)	1.4 (0.02)	1.1 (0.02)	1.3 (0.02)	1.5 (0.03)	1.6 (0.03)	1.3 (0.03)	1.2 (0.02)	1.2 (0.02)
Slovenia	2.5 (0.03)	1.7 (0.03)	2.0 (0.03)	1.3 (0.02)	1.7 (0.03)	1.4 (0.02)	1.6 (0.03)	1.5 (0.03)	1.1 (0.01)	1.1 (0.01)	1.5 (0.03)
[†, 2] Alberta Province, Canada	2.8 (0.04)	1.8 (0.05)	2.1 (0.05)	1.5 (0.04)	1.2 (0.02)	1.5 (0.04)	1.5 (0.04)	1.6 (0.04)	1.1 (0.02)	1.3 (0.04)	1.4 (0.04)
[#] Denmark	2.5 (0.05)	1.9 (0.03)	2.3 (0.04)	1.5 (0.03)	1.2 (0.02)	1.4 (0.03)	1.6 (0.04)	1.8 (0.04)	1.3 (0.03)	1.2 (0.04)	1.3 (0.03)
[#] Estonia	2.5 (0.06)	2.5 (0.06)	1.7 (0.05)	1.3 (0.04)	1.3 (0.05)	1.3 (0.04)	1.6 (0.06)	1.5 (0.05)	1.9 (0.06)	1.2 (0.03)	1.3 (0.04)
[#] France	2.4 (0.04)	1.6 (0.03)	1.7 (0.04)	1.2 (0.02)	1.2 (0.03)	1.3 (0.03)	1.1 (0.01)	1.3 (0.02)	1.1 (0.02)	1.1 (0.02)	1.2 (0.02)
[†, 2] Lithuania	2.2 (0.04)	1.9 (0.04)	2.1 (0.05)	1.7 (0.05)	1.8 (0.04)	1.5 (0.04)	1.9 (0.04)	1.9 (0.04)	1.9 (0.06)	1.3 (0.05)	1.3 (0.04)
[†] Moscow, Russian Federation	2.7 (0.04)	2.3 (0.04)	1.6 (0.03)	1.5 (0.03)	1.2 (0.02)	1.3 (0.02)	1.4 (0.03)	1.8 (0.04)	1.7 (0.04)	1.1 (0.02)	1.1 (0.02)
[#] Norway	2.4 (0.04)	2.0 (0.05)	2.2 (0.04)	1.4 (0.04)	1.4 (0.04)	1.4 (0.04)	1.6 (0.05)	1.7 (0.04)	1.1 (0.02)	1.1 (0.02)	1.7 (0.07)
[†] Russian Federation	2.8 (0.04)	2.3 (0.06)	1.6 (0.04)	1.4 (0.05)	1.1 (0.03)	1.3 (0.04)	1.1 (0.02)	1.7 (0.04)	1.5 (0.05)	1.1 (0.01)	1.1 (0.02)
[†] South Africa	2.0 (0.05)	1.6 (0.04)	1.3 (0.03)	1.3 (0.03)	1.2 (0.02)	1.2 (0.02)	1.2 (0.02)	1.5 (0.03)	1.4 (0.03)	1.4 (0.03)	1.2 (0.02)
[†, 1] Thailand	2.2 (0.04)	1.6 (0.04)	1.7 (0.04)	1.4 (0.03)	1.4 (0.03)	1.3 (0.03)	1.5 (0.04)	1.8 (0.04)	1.3 (0.03)	1.2 (0.03)	1.3 (0.04)

Notes:

Value labels for the response categories: 1=never, 2=sometimes, 3=often, 4=nearly always

[#] School participation rate after including replacement schools is below 70%

[†] International procedures for target-class selection was not followed in all schools

[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Teacher participation data were collected after survey administration

[4] Nationally defined population covers less than 90% of the nationally desired population.

use of these systems was not unanticipated, given these teachers also reported relatively high levels of separation of learners and teachers in time and space in different pedagogical situations.

We also observed that systems with the lowest reported use of learning management systems were also those with teachers reporting the lowest levels of separation in time or space. However, it was intriguing to find that Chile, which was one of the countries reporting the highest use of learning management systems, had the lowest mean separation scores for teaching and learning activities (except for separation in space, when students were participating in planned learning activities). This example from Chile indicates that learning management systems (or any other ICT-related infrastructure or learning resources) may be deployed very differently in different systems; it would be interesting to explore these differences further.

5.3.4 Methods of assessing students' learning outcomes and use of ICT during that process

Assessment is an important part of the pedagogical process. Assessment can be summative, in that it measures students' achievement at the end of a program of study, as well as formative, by providing information for evaluating the effectiveness of the pedagogical process. In the survey, teachers were presented with a list of eight assessment methods and asked whether they had used any of them in their teaching of the target class during the year and whether they had used ICT to carry out those assessments. Different assessment methods are designed to measure different kinds of learning outcomes. Hence, the choice of assessment methods can be seen as a reflection of the "actual" priorities in terms of the curriculum goals held by the teacher and his or her school. The assessment methods in turn influence the pedagogical strategies employed by the teacher through the kind of learning outcomes that these preferentially measure. The eight assessment methods can be categorized into three groups based on the nature of the assessment methods (see Box 5.4 for details).

We grouped written tests/examinations and written tasks/exercises into one category labeled "traditionally important assessments" because teachers have used these to assess students' learning for centuries. Our second category comprised assessments based on the *products* created by students as part of their learning process. These included *individual oral presentation*, *group presentation (oral/written)*, and *project report/multimedia products*. The last category consisted of assessment methods that encourage *reflection and collaboration*, and includes *students' peer evaluations*, *portfolio/learning logs*, and *group performance on collaborative tasks*.

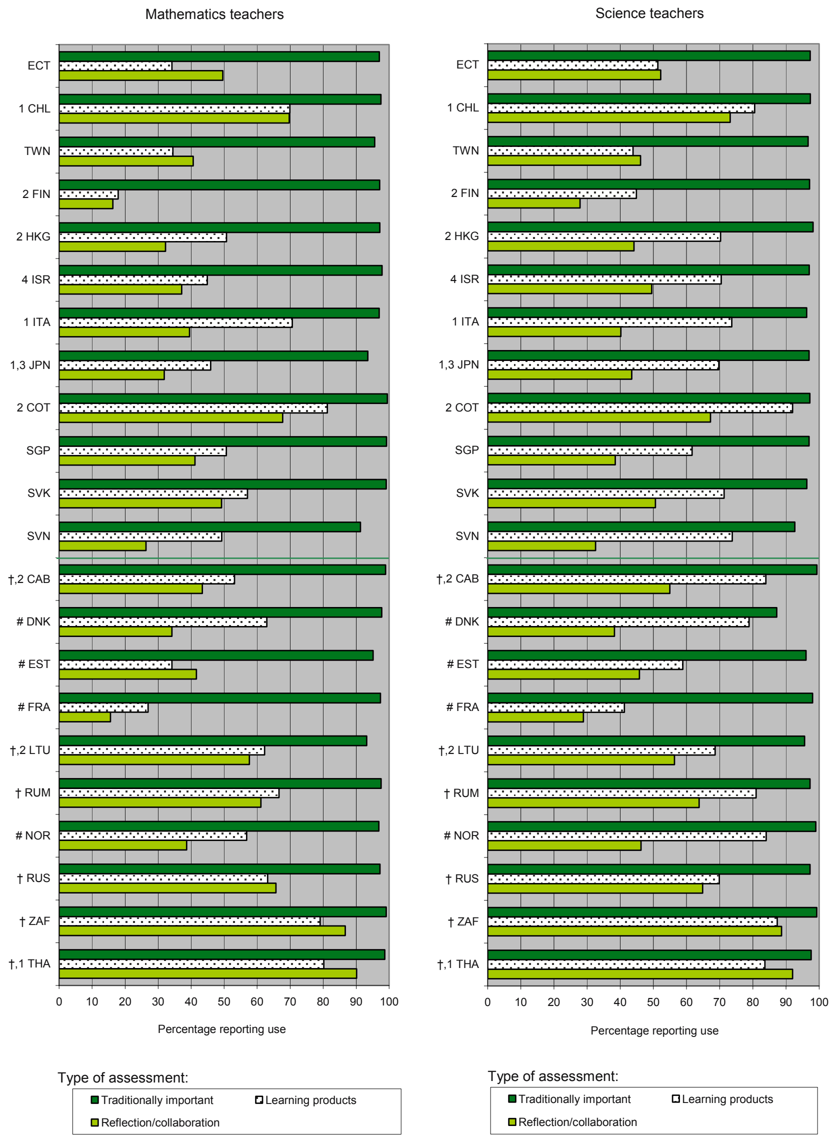
Box 5.4 List of assessment methods included in the teacher questionnaire

Type of assessment	Assessment methods
Traditionally important assessments	• Written test/examination • Written task/exercise
Learning products	• Individual oral presentation • Group presentation (oral/written) • Project report/multimedia product
Reflection/collaboration	• Students' peer evaluations • Portfolio/learning log • Assessment of group performance on collaborative tasks

Figure 5.11 shows the mean percentages of reported use for the assessment methods within each of the three categories as reported by the mathematics and the science teachers. The results presented in Figure 5.11 indicate similarities and differences across systems. First, nearly all teachers in all systems were using traditionally important assessment methods. Second, mathematics and science teachers within the same system showed greater similarity in their assessment practice than did teachers of the same subject across different systems. This finding suggests that assessment practice is an important part of the curriculum and is more strongly influenced by system-level factors than by differences across subject disciplines.

Despite the prevalence of traditionally important assessment methods, newer approaches to assessment were being used "very frequently" in some systems. In Thailand and South Africa, the mean percentages of reported use of *learning products* and *reflection/collaboration* in assessment reached about 80% or above, indicating that most teachers in these systems had already adopted such assessment practices with their target class. In fact, the mean percentage use of learning products in assessment was higher than 50% as reported by science teachers in a large majority of the participating systems; the exceptions included Chinese Taipei and Finland. The reported use of learning products in assessment by mathematics teachers was also higher than 50% in most countries; among the exceptions were Catalonia,

Figure 5.11 Mean percentages of mathematics teachers and science teachers using the three types of assessment methods



Notes:
#School participation rate after including replacement schools is below 70%
†International procedures for target-class selection were not followed in all schools
[1]School participation rate before including replacement schools is below 85%
[2]School participation rate after including replacement schools is below 85%
[3]Teacher participation data were collected after survey administration
[4]Nationally defined population covers less than 90% of the nationally desired population.

Chinese Taipei, Finland, Israel, Japan, and Slovenia. However, the mean reported use of reflection/collaboration for assessment was lower than 50% in most systems, and science teachers generally were more likely than mathematics teachers to report this use.

While assessment based on reflection and collaboration was typically the form of assessment least frequently used in the majority of participating countries, there were some notable exceptions. These included Chinese Taipei and Catalonia, where both mathematics teachers and science teachers were more likely to use this type of assessment than assessment based on learning products.

It is noticeable that in comparison with mathematics teachers, science teachers across all systems were making wider use of the newer assessment methods. This overwhelmingly general trend around the world irrespective of the many different contextual factors is rare and warrants further exploration.

But does the adoption of the newer assessment methods relate in any way to the pedagogical orientation profile of a system? The results in Figure 5.11 show that, across systems, Chile and Ontario were amongst those with the most prevalent use of learning products and reflection/collaboration for assessment purposes. The mathematics and the science teachers in the two countries also had relatively high scores for the 21st-century teacher-practice orientations (lifelong learning and connectedness; see Figure 5.2). Conversely, in Finland, for both populations of teachers, the mean percentages of reported use of the newer assessment methods were among the lowest internationally. The Finnish mathematics and science teachers also reported relatively low scores for the 21st-century teacher-practice orientations. This finding appears to offer evidence of assessment practices correlating with the teachers' pedagogical-practice orientations. However, such relationships are also variable. For example, although the mean percentages of reported use of the newer assessment methods by Japanese mathematics and science teachers were somewhere between the highest and the lowest system means found in all participating countries, Japan had the lowest national means for the 21st-century teacher-practice orientations. The relationship between assessment practice and pedagogical orientation as well as how these influence each other need to be further explored through cross-national comparisons as well as further analysis at the intra-system level.

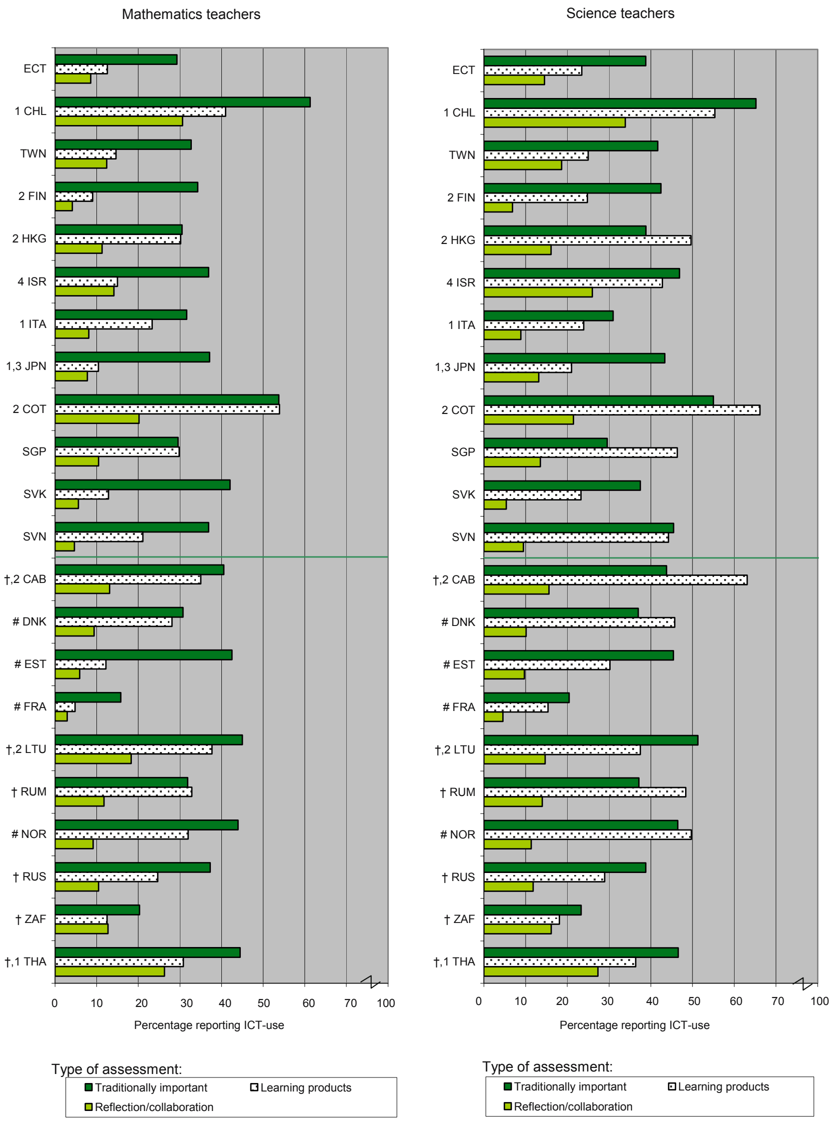
Data on teachers' use of ICT in assessment practices were also gathered through the teacher questionnaire. Figure 5.12 shows the mean percentages of mathematics teachers and science teachers reporting having used ICT to conduct the three categories of assessment practices. Because of the unlikelihood of all assessment being conducted with ICT, the mean percentages reported in this figure are lower than the respective percentages in Figure 5.11. However, if we compare the results presented in these two figures, we quickly see that the extent to which teachers adopted ICT in their assessment practices varied greatly across systems. Science teachers in Chile and Ontario were those teachers who most commonly used ICT in their assessment practices: mean percentages reached more than 60% for some categories. In several other countries, teachers' mean-percentage use of ICT in assessment was relatively low. This was particularly the case in regard to mathematics teachers' assessment of learning products and reflection/collaboration. In Finland and Japan, for example, mean levels were below 10%.

As reported in Sections 5.2.3 and 5.2.4, the profile of pedagogical orientations in ICT-using practices often differed from the overall profile in many systems. How, then, did the ICT-using assessment practices compare with the overall assessment practices? A comparison of Figures 5.11 and 5.12 indicate large differences across systems in the relationship between these two kinds of assessment practices.

In most systems, and particularly for mathematics teachers, ICT-use in assessment was highest in the category of traditionally important methods. However, this percentage was much lower than the overall percentage of teachers reporting the use of this type of assessment. The mean percentage of ICT-use in traditionally important assessment was less than 50% in both populations of teachers, except for teachers in Chile and Ontario. A different pattern was observed in the assessment practices of mathematics teachers in Hong Kong, Ontario, and Singapore, and of science teachers in systems such as Hong Kong, Ontario, and Singapore. In these systems, ICT-use was more prevalent in assessment involving learning products than in traditionally important assessment.

Another observation is that science teachers in the participating systems were not only more likely to make use of non-traditional assessment methods but also more likely to make use of ICT when assessing their students. The latter observation held for all three types of assessment methods and is consistent with a similar comparison result between mathematics teachers and science teachers in terms of their overall and ICT-using teacher-practice orientation profiles reported in Sections 5.1.2 and 5.2.1.

Figure 5.12 Mean percentages of mathematics teachers and science teachers using ICT in each of the three types of assessment methods



Notes:
[#]School participation rate after including replacement schools is below 70%
[†]International procedures for target-class selection were not followed in all schools
[1]School participation rate before including replacement schools is below 85%
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5.4 Extent and perceived impacts of ICT-use on teaching and learning

In addition to the many questions that asked about the teachers' views on and their use of ICT for different kinds of activities, there was one question that asked teachers if they had used ICT in any type of pedagogical activity involving their target class. This was an unambiguous question because it simply asked whether the teacher had made any use at all of ICT in any kind of pedagogical activity during the school year in which the survey took place. Those teachers who answered that they had used ICT were then directed to indicate their perceived impacts of ICT-use on themselves and on their students. This section reports the findings relating to these questions.

5.4.1 Prevalence of ICT-use in mathematics classrooms and science classrooms

Figure 5.13 presents, for all participating systems, the percentages of mathematics teachers and science teachers who reported having used ICT with their target classes. The figure makes apparent the very large differences across the systems. The lowest usage levels were reported by mathematics teachers (18% of the teachers) and science teachers (15.9%) in South Africa. At the other end of the spectrum, very high percentages—over 80%—of science teachers in Singapore and Hong Kong and of mathematics teachers in Norway reported using ICT. Despite the large variations across systems, the results indicate that the pedagogical adoption of ICT by both science and mathematics teachers is becoming a common phenomenon.

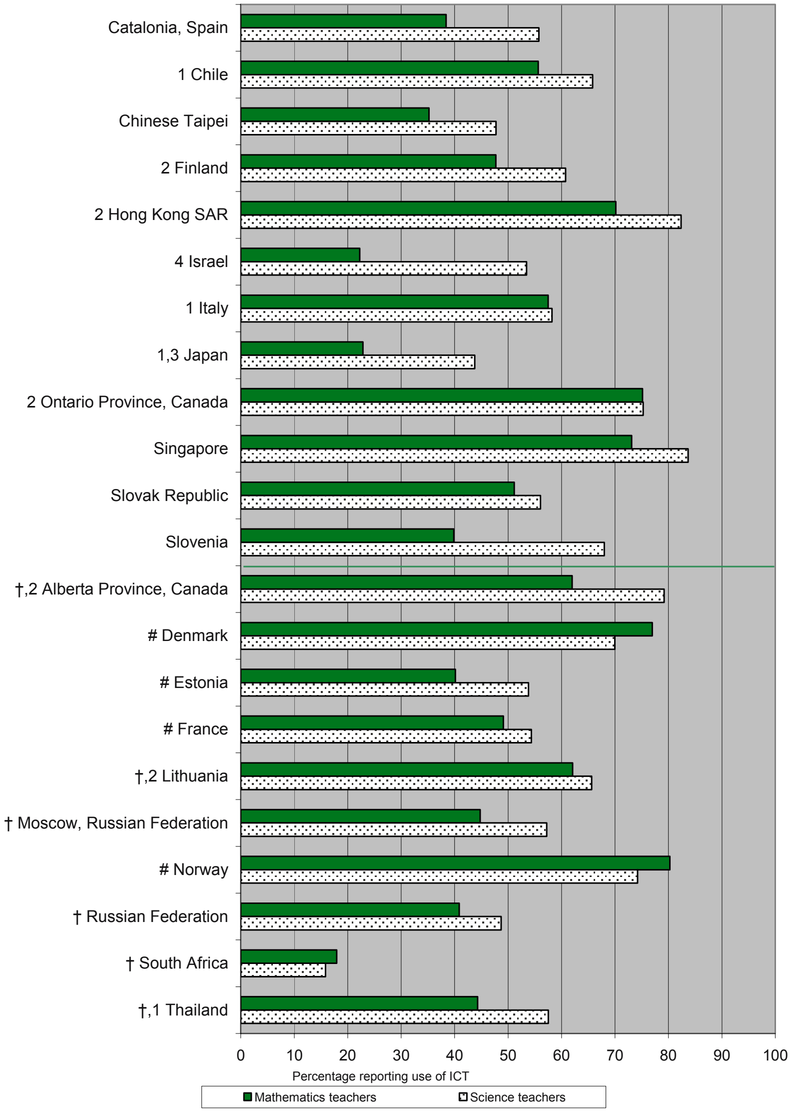
In a majority of the participating systems, the percentage of teachers reporting ICT-use was higher for science teachers than for mathematics teachers within the same system. Further, with the exception of South Africa, more than 40% of science teachers in all the participating systems reported having used ICT with their target class, with levels generally reaching 50% or higher. Five systems other than South Africa had less than 40% of their mathematics teachers reporting use of ICT with their target class. They were Catalonia, Chinese Taipei, Israel, Japan, and Slovenia. However, in less than half of the participating systems, 50% or more of the mathematics teachers had used ICT with their target class.

Chapter 4 noted that, except for South Africa, all the participating systems had access to ICT for learning and teaching. Several noteworthy observations about the data that informs this present chapter can be made in relation to this Chapter 4 finding. First, although integration of ICT into both science and mathematics classrooms is becoming commonplace in many countries around the world, the fact that sizeable proportions of the science teachers and the mathematics teachers surveyed had not *once* used ICT with their target class within the specified academic year indicates that the pedagogical potential of ICT remains largely untapped. This concern warrants special attention from policymakers, school leaders, and teachers. Specifically, interested parties within each system need to gain a better understanding of the factors influencing the adoption of ICT and how they can additionally exploit and develop such potentials in their own systems.

Further to the general observation that fewer mathematics teachers than science teachers in the same system reported using ICT, the difference between these two percentages varied widely across systems. In some systems, such as Italy, Ontario, and the Slovak Republic, this difference was less than 10%. In several other countries, such as Israel, Japan, and Slovenia, the difference was found to be greater than 20%. This difference was particularly remarkable in the case of Israel where the percentage of science teachers reporting use of ICT was more than double that of mathematics teachers, at 22.3% and 53.5% respectively.

The very large differences in percentage of ICT-using mathematics teachers and science teachers found in some systems are very intriguing. Literature (e.g., Jones, 2004; Scrimshaw, 2004) identifies ICT-infrastructure, the ICT-related technical support and professional development available, school culture, and the pedagogical/professional support available as the key factors influencing ICT-adoption. Given that the samples of mathematics teachers and science teachers were taken from the same schools, we could assume no significant difference in terms of these factors would have emerged at the school level for the two populations of teachers from the same system. Explanation for the large difference observed between the two sets of teachers in these systems appears to be related, prima facie, to differences that may exist at the system level. The national research coordinators of some of these systems remarked that the differences could be attributed to differences at the national curriculum-policy level, but further investigations are warranted to identify the specific contributing factors, as these might be different in the different systems.

Figure 5.13 Percentages of mathematics teachers and science teachers reporting having used ICT in the teaching and learning activities of their target classes



Notes:

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[†]International procedures for target-class selection were not followed in all schools

[1]School participation rate before including replacement schools is below 85%

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As previously mentioned, it seems reasonable to expect that the level of ICT-infrastructure available within a system will influence the extent to which teachers adopt ICT into their pedagogical practices. However, the results from this study present no definitive relationship at the system level between indicators for ICT-infrastructure such as student–computer ratios (see Chapter 4, Figure 4.6 for details) and the percentage of teachers using ICT for teaching and learning. For example, Japan and Chinese Taipei reported relatively high levels of ICT- availability but rather low percentages of teachers using ICT. Some explorations on the relationship between school- and teacher-level variables are presented in Chapter 8.

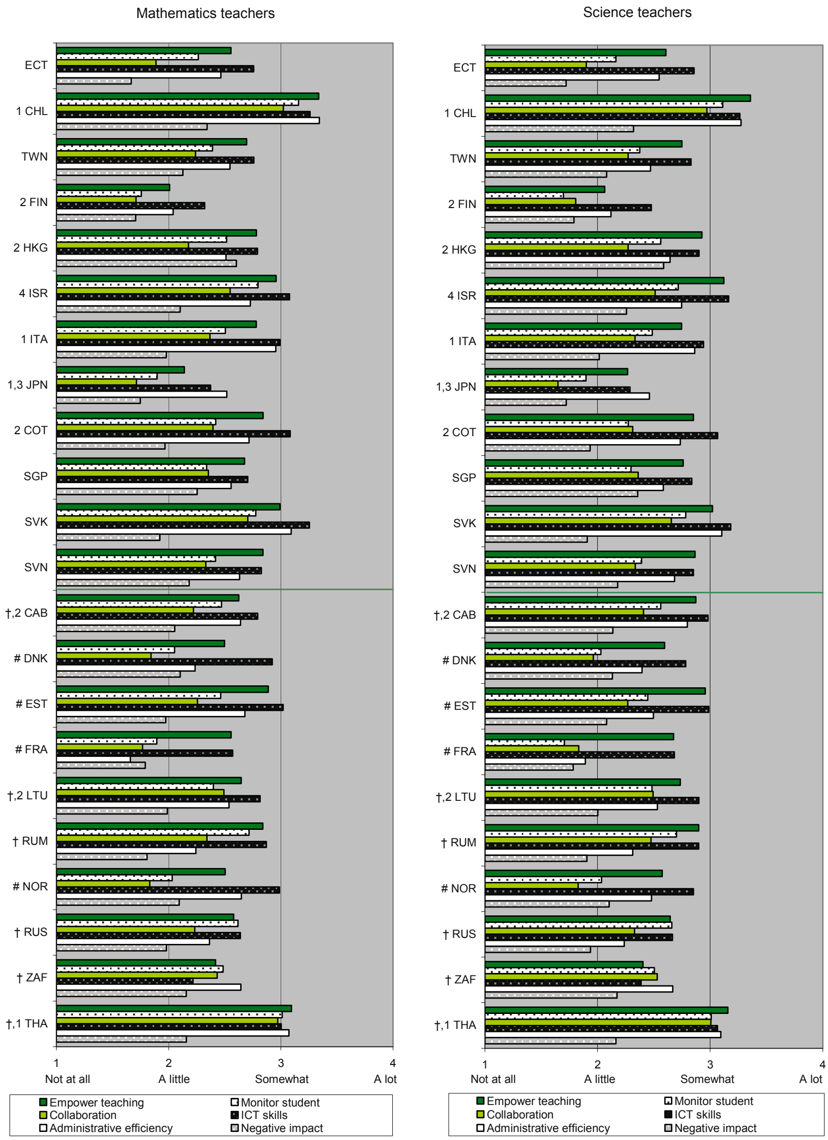
5.4.2 Teachers' perceived impact of ICT-use on self

Teachers who indicated that they had used ICT when teaching their target classes were asked to indicate (on a four-point Likert scale, ranging from 1=not at all to 4=a lot) the extent to which ICT-use had had an impact on any of 12 specified aspects related to themselves and their teaching work. We grouped these 12 aspects into six categories to give six impact indicators. These are listed in Box 5.5. Figure 5.14 presents the mathematics teachers' and science teachers' mean perceived impacts of ICT-use on themselves in all participating systems.

Box 5.5 Kinds of impact of ICT-use on teachers

Kinds of impact	Specific impact
Empower teaching	• Incorporate new teaching methods • Incorporate new ways of organizing learning • Access more diverse/higher quality learning resources
Better monitoring/ feedback to students	• Provide more individualized feedback • Monitor more easily students' learning progress
Enhance collaboration	• Collaborate more with colleagues • Collaborate more with peers and experts outside school
ICT-skills	• Improved ICT-skills
Administrative efficiency	• Able to complete administrative tasks more easily
Negative impacts	• Increased workload • Increased work pressure • Have become less effective as a teacher

Figure 5.14 Mathematics teachers' and science teachers' perceived impact of ICT-use on themselves



Notes:

#School participation rate after including replacement schools is below 70%

†International procedures for target-class selection were not followed in all schools

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Except for a few cases, the mean perceived impact was, as evident in Figure 5.14, between "a little" and "somewhat," indicating that teachers experienced some, but rather limited, extents of impacts due to ICT-use. Consistent with the finding reported above that, in most systems, a higher percentage of science teachers than mathematics teachers were using ICT for pedagogical purposes, the levels of perceived impacts of ICT-use reported by science teachers was also generally somewhat higher.

The perceived impacts of ICT-use on self were highest for *ICT-skills* and *empower teaching.* The perceived impact of ICT-use on *administrative efficiency* was also very high in some systems, such as Chile, the Slovak Republic, and Thailand. Interestingly, the perceived impact of ICT-use on enhancing teachers' collaboration was not high, gaining only fifth place in most systems among all six types of perceived impacts. The results also indicate that teachers generally had a positive perception of the impact of ICT-use. This is evidenced by the fact that, in most systems, teachers saw "negative impact" as having the lowest level of impact on themselves, which means they were focusing more strongly on the positive impacts of ICT-use than on the negative impacts.

It is noteworthy that the levels of perceived positive impact did not bear clear relationships with the levels of reported ICT-use. Only a few systems (e.g., Chile, Israel, Ontario, and the Slovak Republic) saw both teacher populations reporting at least one impact with a mean above 3.0 (i.e., "somewhat" on the Likert scale). Of these, only Ontario was among the systems in which high percentages of teachers were using ICT. We found the relatively high level of perceived impact reported by ICT-using mathematics teachers in Israel the most surprising outcome in this set of results given that only 22.3% of the population reported having used ICT with the target class. The possibility that those Israeli mathematics teachers who had chosen to use ICT were relatively self-motivated and convinced of the pedagogical potential of ICT warrants confirmatory exploration.

5.4.3 Impact of ICT-use on students as perceived by mathematics teachers and science teachers

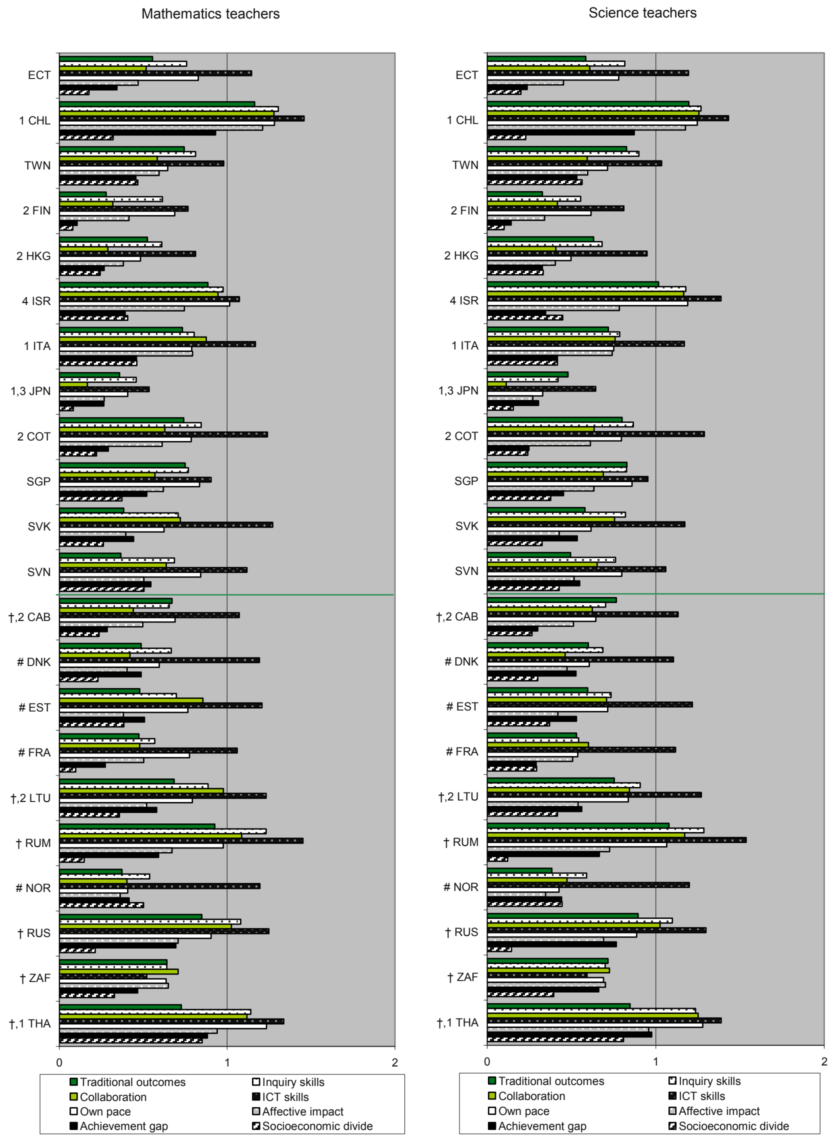
Teachers who indicated they had used ICT when teaching their target classes were also asked to report to what degree ICT-use had influenced their students in 15 different areas. We categorized these impacts into eight groups as listed in Box 5.6. Teachers were asked to report each impact on a five-point Likert scale (1= decreased a lot, 2=decreased a little, 3=no impact, 4=increased a little, and 5=increased a lot). Thus, teachers could indicate each impact as positive or negative.

Box 5.6 Kinds of impact of ICT-use on students

Kinds of impact	Specific impact
Traditional outcomes	• Subject-matter knowledge • Assessment results
Inquiry skills	• Information-handling skills • Problem-solving skills • Self-directed learning skills
Collaboration	• Collaborative skills • Communication skills
ICT-skills	• ICT-skills
Self-paced learning	• Ability to learn at own pace
Affective impact	• Learning motivation • Self-esteem • Time spent on learning • School attendance
Achievement gap	• Achievement gap between students
Socioeconomic divide	• Inequity between students from different socioeconomic backgrounds

Figure 5.15 displays the mean scores of the eight types of impact as perceived by the science and the mathematics teachers in all participating systems. Because none of the mean values was below zero across all eight types of impact, we started the x-axis in the figure at “0.” However, a positive score is not necessarily a positive impact. An increase in the achievement gap among students and an increase in inequity between students from different socioeconomic backgrounds are both educationally negative outcomes. Hence, for the last two impact categories listed in Box 5.6, a positive score should be interpreted as a negative impact. These results therefore indicate that the use of ICT has not helped to narrow the achievement gap between students nor the socioeconomic divide. Nonetheless, it is comforting to note that the perceived impacts in these two areas were lower than those perceived in relation to the other six areas, indicating that teachers generally saw the positive impacts on students outweighing the negative ones.

Figure 5.15 Mathematics teachers' and science teachers' perceptions of extent of various kinds of impact of ICT-use on students



Notes:

There were five response categories: decreased a lot (-2), decreased a little (-1), no impact (0), increased a little (1), increased a lot (2). Because none of the mean values was below zero, the x-axis starts from "0".

[#]School participation rate after including replacement schools is below 70%

[†]International procedures for target-class selection were not followed in all schools

[1]School participation rate before including replacement schools is below 85%

[2]School participation rate after including replacement schools is below 85%

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The results presented in Figure 5.15 indicate that the highest impact on students was in the area of improved ICT-skills as perceived by both mathematics and science teachers in all participating systems. The profiles of the different perceived impacts on students were very similar across the two teacher populations, indicating that both perceived ICT to have brought about small, but positive, impacts on students in various areas of affective and cognitive outcomes.

In reviewing the profile of the perceived extents of impact within the various categories, we observed that in some systems, such as Catalonia, Ontario, and the Slovak Republic, the perceived impact in areas other than ICT-skills was much lower. In some other systems, such as Chile and Israel, the perceived impacts on the other cognitive and affective outcomes aligned with gains in ICT-skills. In particular, the teachers considered that ICT had brought about comparable gains in inquiry skills, collaboration, and the ability of students to work at their own pace. The teachers also generally thought that use of ICT had produced positive impacts on students' subject-matter knowledge and assessment results (i.e., traditional outcomes), although they did not rate the extent as particularly high.

We next asked ourselves if higher levels of ICT-use by teachers would be associated with greater perceived impacts of ICT-use on students. Preliminary explorations at the system level showed no such relationship. For example, the levels of ICT-use reported by the science teachers were generally higher than those reported by the mathematics teachers. However, both populations of teachers within a same system were very alike in their perception of the impacts of ICT-use on students. Further, the perceived impacts tended to be rather low in a system reporting high levels of use, such as Hong Kong. At the other extreme, those systems that registered the highest levels of perceived impact on students, such as Chile and Israel, did not correspond to those reporting high levels of ICT-use during teaching of the target class. It is important to note that teachers' perception of the impact of ICT-use on students may relate not only to their own pedagogical use of ICT but to students' general use of ICT in their daily activities.

5.4.4 Teachers' pedagogical orientation relative to teachers' perceptions of impact of ICT-use on students

One important question to explore is whether the concept of pedagogical orientation has value in helping us understand the use of ICT in learning and teaching. In particular, does pedagogical orientation matter in terms of the impact of ICT-use on students' learning outcomes? Obviously, this question cannot be addressed in the context of the present study. However, we were able to investigate whether teachers' perceived impact of ICT-use on their students related in any way to their pedagogical orientation. While more in-depth analyses can be undertaken, a correlational analysis at the system level revealed some interesting findings. Table 5.3 shows the correlations between the system means for the three ICT-using teacher-practice-orientation scores relative to the eight categories of impacts on students as perceived by science teachers (corresponding results for mathematics teachers can be found in Table W5.3M at http://www.sites2006.net/appendix).

Table 5.3 Correlations of system means of teacher-practice-orientation scores with corresponding mean impact scores of ICT-use on students as perceived by science teachers

Science		ICT-using teacher practice orientations		
		Traditionally important	Lifelong learning	Connectedness
Kinds of impact on students	Traditional outcomes	0.50	0.64 *	0.32
	Inquiry skills	0.38	0.77 **	0.49
	Collaboration	0.24	0.76 **	0.56
	ICT skills	0.22	0.72 **	0.53
	Self-paced learning	0.23	0.74 **	0.60 *
	Affective impact	0.35	0.71 *	0.51
	Achievement gap	0.48	0.65 *	0.33
	Socioeconomic divide	0.40	0.38	-0.01

Notes:

Systems not meeting the requisite participation rate or not following the procedures for target-class sampling were excluded from the computation of the correlations; hence, $N=12$

* Correlation is significant at the 0.05 level (2-tailed)

** Correlation is significant at the 0.01 level (2-tailed).

The correlations between the teachers' perceived impact of ICT-use on students and the ICT-using teacher-practice scores revealed a distinctly different pattern for each of the three orientations. Not one statistically significant correlation emerged between the ICT-using traditionally important scores and any of the eight categories of perceived student outcomes. The ICT-using connectedness score significantly correlated with only one of the outcome categories—self-paced learning. The ICT-using lifelong-learning scores, however, showed significantly positive correlations with all of the perceived student- outcome categories except socioeconomic divide. The correlations were highest for inquiry and collaboration skills, and lowest for traditional outcomes.

It appears from the above analysis that the relationship between ICT-use and perceived student outcomes differ greatly depending on the pedagogical orientation of ICT-using pedagogical practices. While it is heartening to see that lifelong learning-oriented pedagogical uses of ICT appear to correlate positively with the development of 21st-century outcomes in students, the corresponding positive correlation with the increase in achievement gap is worrying. Why is it that higher scores for ICT-using lifelong-learning teacher practices show a positive correlation with a perceived increase in achievement gap? How far does this perception match with reality? These are issues that warrant further research and investigation.

5.5 Summary

The findings reported in this chapter shed light on whether pedagogical changes have actually taken place in schools around the world in response to the new educational goals compatible with 21st-century requirements and whether teachers' use of ICT is related to their pedagogical orientations.

We found that, around the world, the traditionally important orientation was still the most dominant. However, we also found that while the teachers in the different systems had, to varying degrees, adopted the lifelong-learning orientation, this could not be said of the connectedness orientation, which was the weakest in all the participating systems. In both teacher and student practices, systems with a relatively stronger presence of the lifelong-learning orientation also exhibited a stronger connectedness orientation, giving empirical support to grouping these two orientations together as the 21st-century pedagogical orientation.

The scores for the 21st-century orientation indices were highest for the espoused curriculum goals and lowest for the student-practice indices, indicating that the 21st-century goals had gained wide conceptual acceptance by teachers. However, the extent to which 21st-century practices had been realized at the time of the SITES 2006 survey was relatively limited, particularly in the area of student practice. These findings provide evidence that pedagogical changes are taking place in ways advocated within the education reform policies of the 21st century.

However, the change beyond the rhetoric level (as reflected by the teachers' espoused curriculum goals) is more difficult to discern, and we found that it was easier to see changes in teacher practices than in student practices. Nonetheless, we could also see considerable differences in pedagogical orientation between ICT-using and overall practices for student practices than for teacher practices, with the ICT-using practices showing a stronger 21st-century orientation. One implication of this pattern is that some systems are more successful than others in bringing about changes in student and teacher practices that align with 21st-century curriculum goals. A further implication is that once appropriate policy and contextual conditions are in place, integration of ICT into the curriculum will produce the desired pedagogical changes.

Generally, higher percentages of ICT-use were evident among science than mathematics teachers. The percentage of teachers who reported having used ICT in their teaching of the target class differed widely across systems, varying from over 80% to below 20%. In some systems, the low level of access may have related to inadequate ICT-infrastructure. However, the large difference in the percentages of ICT-using science teachers and mathematics teachers within the same system (which were sampled from the same schools) clearly point to more complex factors than ICT-infrastructure and other general school factors influencing ICT-use.

Why is it that teachers in some systems seem to have preferentially selected to use ICT more for 21st-century teacher and student practices while those in some other systems selected the reverse? It is certainly of great interest to policymakers and teacher educators to explore further the factors contributing to such differences across systems.

In terms of ICT-use in assessment, the mean percentage of reported ICT-use in traditionally important assessment practice was less than 50% as reported by the mathematics and the science teachers in most of the participating systems, even though nearly all teachers were using this kind of assessment in their general assessment practice. In some systems, the mean percentage use of ICT was higher in the assessment of learning products than in the assessment of traditionally important tasks.

The teachers' perceptions of the impacts of ICT-use on self and on students were generally positive, while the mean levels of negative impacts were relatively low. The highest perceived impacts on teachers themselves were *ICT-skills* and *empower teaching*. Moreover, the perceived impact of ICT on enhancing teachers' collaboration was not high, and higher levels of reported ICT-use were not necessarily associated with higher levels of perceived learning outcomes. Analyses further indicated a high likelihood that teachers' pedagogical orientations correlate with students' learning outcomes. We found the lifelong-learning and connectedness orientations in both overall and ICT-using teacher practices significantly associated with better learning outcomes, particularly skills such as collaboration and inquiry that are considered important for personal and societal wellbeing in the 21st century.

Chapter Six

Teacher Characteristics, Contextual Factors, and How These Affect the Pedagogical Use of ICT

Nancy LAW and Angela CHOW

Whether and how teachers use ICT in their teaching and their pedagogical orientations are influenced by personal, organizational, and system-level factors. In accordance with the conceptual framework described in Chapter 2, the teacher questionnaire was designed to collect data on a number of variables related to these three categories of factors. Questions related to the personal characteristics of the teacher included demographic information (age, gender, highest level of academic qualification reached, possession or otherwise of a teaching license) and his or her self-perceived technical and pedagogical competence when using ICT. The teachers were also asked to respond to a number of questions related to their experiences of factors at the school and system levels: (1) the availability and usefulness of different kinds of professional development activities; (2) obstacles to realizing their [teachers'] vision for ICT-use; and (3) the presence of features indicative of a community of practice in the school.

This chapter begins by profiling the mathematics teachers' and science teachers' characteristics and these teachers' perceptions of the specified school- and system-level factors. In addition, we offer some preliminary explorations concerning possible relationships between the personal-, school-, and system-level factors and whether the teachers were using ICT when teaching the target classes. In cases where

N. Law et al. (eds.), Pedagogy and ICT Use in Schools around the World, 181–219.

categorical data such as gender were collected, we also present the percentage of teachers in each category who reported using ICT with the target class. This information allowed us some initial insights into whether and how these characteristics (captured through categorical data) correlated with teachers' use of ICT when teaching. For contextual data that are, by nature, continuous, such as the teachers' self-reported competence and the extent to which obstacles or support were present, we used binary logistic regression analysis to explore the relationship, and we report the key findings later in this chapter. While more sophisticated explorations on the relationships between various personal and contextual factors with the different aspects of teachers' pedagogical use of ICT reported in Chapter 5 are clearly warranted, these have been beyond the scope of this first international report. Hopefully, however, the work presented in this publication will be followed by more in-depth analysis at system and cross-national levels.

6.1 Teachers' demographic characteristics and pedagogical uses of ICT

The teacher questionnaire collected personal information that might have influenced the participating teachers' pedagogical uses of ICT. This information included age, gender, highest level of academic qualification reached, attainment of a teaching license, and self-reports of technical and pedagogical ICT-competence. This section reports the findings on these basic demographic characteristics.

6.1.1 Teachers' age

Tables 6.1a and 6.1b present, for each participating system, the percentages of mathematics teachers and the percentages of science teachers belonging to the different age groups. The most obvious pattern in the tables is the large variation in the age profiles of the teachers in different systems. In some systems, such as Chinese Taipei, Hong Kong SAR, and Singapore, most of the teachers who participated in SITES 2006 were below age 40 and so had an age profile younger than those of the teachers in systems such as Finland, Italy, and Moscow, where the majority of the teachers were above the age of 40.

An examination of the results presented in Tables 6.1a and 6.1b shows no single identifiable trend across systems. For mathematics teachers (Table 6.1a), we can see that the age cohort with the highest percentage of ICT-using teachers differs across systems and that, with the exception of the oldest age group (>49), the number of systems with the highest percentage of ICT-using teachers falling in each of the other three age groups is basically the same. It is interesting to note that the two systems which had the highest percentage of ICT-using mathematics teachers in the oldest age group were Chinese Taipei and Singapore, although both have a relatively young age profile overall for these teachers. This finding seems to indicate that although age-related patterns in teachers' use of ICT were evident in some systems, age is not a determining factor but may instead be a contributing one in terms of working through other age-related circumstantial factors that vary from system to system.

For the science teachers, the pattern evident in Table 6.1b is slightly different from that for the mathematics teachers. The two science-teacher age groups in the middle (30 to 39 and 40 to 49) had the greatest number of systems with the highest percentage of ICT-using teachers in them. Unlike the case for the mathematics teachers, none of the systems had the highest percentage of ICT-using teachers in the oldest age group. However, in two systems, Hong Kong and Singapore, more than 80% of the science teachers in the oldest age group (>49) reported having used ICT with their target class. Thus, the science-teacher data also indicate that while age is not a determining factor for pedagogical adoption of ICT, other age-related circumstantial factors may be operating in the different systems. These findings are consistent with findings from earlier studies which show that any anxiety teachers feel about using ICT is not a function of their age (Bradley & Russell, 1997; Rosen & Maguire, 1990).

Another observation was that the variation in patterns of ICT-use between the mathematics teachers and the science teachers across the age groups could be very different even within the same system. For example, in Moscow, the percentages of ICT-using mathematics teachers within the youngest to the oldest age groups were 70%, 52%, 46%, and 35%, a pattern that shows a definite decrease in use with increase in age. The corresponding percentages for Moscow's science teachers of 56%, 64%, 66%, and 48% present a very different profile. These patterns indicate that the age-related contextual factors for the populations of mathematics teachers and science teachers can differ even within the same system. Further system-level exploration is necessary to gain a better understanding of how age affects a teacher's decision to use ICT in his or her teaching practice.

Table 6.1a Number of mathematics teachers in the different age groups and the percentage of mathematics teachers in each age group who had used ICT with their target classes

Education system	<30 years		30-39 years		40-49 years		>49 years		System mean
	N	use ICT %	*N*	use ICT %	*N*	use ICT %	*N*	use ICT %	
Catalonia, Spain	44	51 (0.08)	194	46 (0.04)	223	38 (0.04)	202	26 (0.03)	38 (2.02)
[1] Chile	55	42 (0.07)	94	58 (0.05)	179	57 (0.04)	219	57 (0.03)	56 (2.14)
Chinese Taipei	175	31 (0.04)	365	36 (0.02)	249	36 (0.03)	60	41 (0.07)	35 (1.63)
[2] Finland	52	61 (0.07)	119	56 (0.05)	109	51 (0.05)	269	39 (0.03)	48 (2.54)
[2] Hong Kong SAR	176	67 (0.04)	215	73 (0.03)	122	69 (0.04)	55	67 (0.07)	70 (2.15)
[4] Israel	102	17 (0.03)	266	22 (0.03)	244	24 (0.03)	226	23 (0.03)	22 (1.58)
[1] Italy	6	85 (0.16)	61	63 (0.07)	174	61 (0.04)	411	55 (0.02)	57 (2.07)
[1, 3] Japan	105	24 (0.04)	125	28 (0.04)	164	21 (0.03)	71	17 (0.04)	23 (1.92)
[2] Ontario Province, Canada	82	71 (0.05)	144	76 (0.04)	119	82 (0.03)	65	68 (0.06)	75 (2.33)
Singapore	199	70 (0.03)	166	77 (0.03)	60	70 (0.07)	54	79 (0.06)	73 (1.84)
Slovak Republic	86	50 (0.06)	91	64 (0.06)	145	54 (0.05)	236	45 (0.03)	51 (2.23)
Slovenia	127	41 (0.05)	168	46 (0.04)	299	42 (0.03)	119	24 (0.04)	40 (1.98)
[†, 2] Alberta Province, Canada	70	66 (0.06)	109	64 (0.05)	101	58 (0.05)	75	62 (0.06)	62 (2.47)
[#] Denmark	32	74 (0.09)	100	80 (0.04)	66	89 (0.04)	150	71 (0.04)	77 (2.20)
[#] Estonia	22	36 (0.10)	46	52 (0.08)	94	40 (0.05)	72	33 (0.05)	40 (3.49)
[#] France	73	57 (0.05)	142	54 (0.04)	64	39 (0.06)	138	45 (0.04)	49 (2.56)
[†, 2] Lithuania	29	77 (0.09)	60	66 (0.06)	166	65 (0.04)	122	53 (0.05)	62 (2.75)
[†] Moscow, Russian Federation	52	70 (0.06)	108	52 (0.05)	187	46 (0.04)	249	35 (0.03)	45 (2.35)
[#] Norway	28	83 (0.09)	95	78 (0.05)	53	85 (0.05)	117	79 (0.03)	80 (2.33)
[†] Russian Federation	86	33 (0.11)	259	42 (0.07)	425	41 (0.05)	459	41 (0.06)	41 (3.47)
[†] South Africa	77	15 (0.04)	209	18 (0.03)	150	20 (0.03)	49	15 (0.06)	18 (1.97)
[†, 1] Thailand	168	44 (0.05)	161	45 (0.05)	193	51 (0.05)	142	33 (0.05)	44 (2.56)

Notes:

ICT-use percentages are weighted statistics. However, *N* listed in the tables is the unweighted number of teachers. Age was not part of the sampling criteria and *N* is included to indicate the size of the actual sample within each age bracket

Value labels for the response categories: 1=never, 2=sometimes, 3=often, 4=nearly always

[#] School participation rate after including replacement schools is below 70%

[†] International procedures for target-class selection was not followed in all schools

[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Teacher participation data were collected after survey administration

[4] Nationally defined population covers less than 90% of the nationally desired population.

Table 6.1b Number of science teachers in the different age groups and the percentage of science teachers in each age group who had used ICT with their target classes

	Education system	<30 years		30-39 years		40-49 years		>49 years		System mean
		N	use ICT %	*N*	use ICT %	*N*	use ICT %	*N*	use ICT %	
	Catalonia, Spain	30	65 (0.09)	159	61 (0.04)	193	57 (0.04)	150	44 (0.05)	56 (2.23)
1	Chile	41	68 (0.09)	102	64 (0.05)	177	71 (0.04)	200	62 (0.04)	66 (2.47)
	Chinese Taipei	125	43 (0.05)	347	52 (0.03)	263	48 (0.03)	59	44 (0.06)	48 (1.79)
2	Finland	50	69 (0.07)	126	65 (0.05)	120	70 (0.05)	248	52 (0.04)	61 (2.55)
2	Hong Kong SAR	98	88 (0.03)	181	77 (0.03)	115	85 (0.04)	55	85 (0.05)	82 (1.77)
4	Israel	73	55 (0.06)	232	57 (0.04)	239	50 (0.03)	160	52 (0.04)	53 (2.17)
1	Italy	6	55 (0.19)	69	69 (0.06)	210	63 (0.04)	386	54 (0.03)	58 (2.24)
1, 3	Japan	68	46 (0.06)	106	44 (0.05)	188	48 (0.03)	77	32 (0.06)	44 (2.36)
2	Ontario Province, Canada	72	67 (0.05)	124	77 (0.04)	65	83 (0.05)	43	80 (0.08)	75 (2.31)
	Singapore	176	81 (0.03)	143	85 (0.03)	70	87 (0.05)	57	84 (0.05)	84 (1.71)
	Slovak Republic	173	61 (0.04)	248	65 (0.04)	242	65 (0.04)	407	44 (0.03)	56 (2.12)
	Slovenia	58	65 (0.06)	205	70 (0.03)	309	70 (0.03)	124	59 (0.05)	68 (2.02)
†, 2	Alberta Province, Canada	74	75 (0.05)	124	84 (0.03)	82	80 (0.05)	46	71 (0.07)	79 (2.25)
#	Denmark	41	70 (0.08)	110	75 (0.05)	90	78 (0.04)	168	63 (0.04)	70 (2.57)
#	Estonia	45	53 (0.08)	75	60 (0.06)	117	59 (0.04)	137	48 (0.05)	54 (2.63)
#	France	107	55 (0.05)	169	65 (0.04)	45	58 (0.07)	95	33 (0.05)	54 (2.50)
†, 2	Lithuania	26	61 (0.13)	92	70 (0.05)	165	70 (0.04)	187	60 (0.04)	66 (2.67)
†	Moscow, Russian Federation	140	56 (0.05)	275	64 (0.03)	481	66 (0.03)	675	48 (0.03)	57 (1.91)
#	Norway	27	78 (0.08)	97	77 (0.05)	47	68 (0.07)	103	74 (0.04)	74 (2.69)
†	Russian Federation	293	44 (0.06)	627	53 (0.04)	898	56 (0.04)	1195	42 (0.04)	49 (2.67)
†	South Africa	63	19 (0.06)	174	15 (0.03)	143	16 (0.04)	45	15 (0.06)	16 (1.87)
†, 1	Thailand	138	62 (0.07)	194	56 (0.05)	206	57 (0.04)	116	53 (0.06)	58 (2.69)

Notes:

ICT-use percentages are weighted statistics. However, *N* listed in the tables is the unweighted number of teachers. Age was not part of the sampling criteria and *N* is included to indicate the size of the actual sample within each age bracket

Value labels for the response categories: 1=never, 2=sometimes, 3=often, 4=nearly always

[#] School participation rate after including replacement schools is below 70%

[†] International procedures for target-class selection was not followed in all schools

[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Teacher participation data were collected after survey administration

[4] Nationally defined population covers less than 90% of the nationally desired population.

6.1.2 Teachers' gender

Relevant educational and social research literature shows that males tend to be more technologically savvy and willing than females to learn about new technology (see, for example, Schumacher & Morahan-Martin, 2001; Yuen & Ma, 2002). Males also have lower levels of computer anxiety (Bradley & Russell, 1997). We were interested in whether we would find these gender differences in the male teachers' and the female teachers' use of ICT. Of the systems showing statistically significant gender differences in ICT-use in the paired *t*-test results (see Table 6.2), there were indeed many more systems where the higher usage group was male. In particular, of the seven systems where significant gender differences emerged for both teacher populations, the percentages of males using ICT were higher than the corresponding percentages for female teachers in all but the Russian Federation. The significantly higher percentage of ICT-use among the female teachers in the Russian Federation needs to be qualified by the observation that the proportion of mathematics teachers in the country who were male at the time of SITES was very low (53 males to 1,182 females).

However, simplistic conclusions on gender differences are not warranted. For each population of teachers, there was no statistically significant gender difference in the percentages of ICT-using teachers in half of the participating systems. No statistically significant gender difference was found in relation to the mean scores for both teacher populations in eight systems: Alberta, Catalonia, Estonia, Israel, Lithuania, Norway, Singapore, and the Slovak Republic. Systems in which no significant gender difference was found in one teacher population were Denmark, Hong Kong, and Italy (mathematics teachers), and Chile, Moscow, Ontario, and South Africa (science teachers). There were also systems in which no overwhelming gender imbalance in population size was discernable and yet the percentages of ICT-using female teachers were significantly higher than the percentages of ICT-using male teachers. This pattern was evident for science teachers in Denmark and Hong Kong and for mathematics teachers in Chile. These findings indicate that, despite more systems having higher percentages of ICT-using male teachers for both teacher populations, the gender imbalance is probably not due to gender-specific differences in the pedagogical adoption of ICT. Any such difference is more likely to relate to social, historical, cultural, and other contextual differences between male and female teachers in the specific education systems.

Table 6.2 Number of male teachers and female teachers and the percentage of teachers in each gender group who used ICT with their target classes

	Education system	Mathematics teachers					Science teachers				
		Male		Female		Sig.	Male		Female		Sig.
		N	use ICT %	*N*	use ICT %		*N*	use ICT %	*N*	use ICT %	
	Catalonia, Spain	318	37 (0.03)	344	40 (0.03)		215	54 (0.03)	318	57 (0.03)	
1	Chile	225	51 (0.04)	319	59 (0.03)	**	135	67 (0.04)	389	65 (0.03)	
	Chinese Taipei	419	39 (0.02)	429	32 (0.02)	**	493	51 (0.02)	301	45 (0.03)	**
2	Finland	224	51 (0.04)	327	45 (0.03)	**	213	63 (0.04)	331	59 (0.03)	*
2	Hong Kong SAR	330	68 (0.03)	240	73 (0.03)		263	78 (0.03)	184	89 (0.02)	**
4	Israel	185	25 (0.03)	653	22 (0.02)		125	55 (0.05)	572	53 (0.03)	
1	Italy	121	59 (0.05)	533	58 (0.02)		124	64 (0.05)	545	57 (0.03)	**
1, 3	Japan	315	25 (0.03)	151	18 (0.03)	**	345	46 (0.02)	94	36 (0.06)	**
2	Ontario Province, Canada	182	78 (0.03)	228	74 (0.03)	**	128	76 (0.04)	177	76 (0.03)	
	Singapore	179	73 (0.04)	301	73 (0.03)		169	82 (0.03)	279	85 (0.02)	
	Slovak Republic	105	52 (0.05)	452	51 (0.02)		265	56 (0.04)	796	56 (0.02)	
	Slovenia	143	51 (0.04)	568	37 (0.02)	**	137	77 (0.04)	555	66 (0.02)	**
†, 2	Alberta Province, Canada	179	62 (0.04)	171	62 (0.04)		174	80 (0.03)	154	78 (0.04)	
#	Denmark	222	78 (0.03)	123	76 (0.04)		280	67 (0.03)	128	77 (0.04)	**
#	Estonia	25	45 (0.10)	209	39 (0.04)		70	56 (0.06)	302	54 (0.03)	
#	France	200	55 (0.04)	219	44 (0.04)	**	189	59 (0.04)	225	51 (0.04)	**
†, 2	Lithuania	26	56 (0.10)	350	62 (0.03)		71	64 (0.07)	396	66 (0.03)	
†	Moscow, Russian Federation	17	19 (0.10)	581	46 (0.02)	**	137	59 (0.04)	1435	57 (0.02)	
#	Norway	179	81 (0.03)	114	80 (0.04)		175	76 (0.03)	101	72 (0.04)	
†	Russian Federation	53	38 (0.11)	1182	41 (0.04)	**	319	53 (0.04)	2702	48 (0.03)	**
†	South Africa	230	19 (0.03)	259	17 (0.02)	**	183	15 (0.03)	242	17 (0.03)	
†, 1	Thailand	200	47 (0.04)	457	43 (0.03)	**	188	60 (0.04)	466	56 (0.03)	**

Notes:

ICT-use percentages are weighted statistics. However, N listed in the tables is the unweighted number of teachers. Gender was not part of the sampling criteria and N is included to indicate the size of the actual sample within each gender

Value labels for the response categories: 1=never, 2=sometimes, 3=often, 4=nearly always

School participation rate after including replacement schools is below 70%

† International procedures for target-class selection was not followed in all schools

* Differences between male teachers and female teachers is significant at $p < 0.05$

** Differences between male teachers and female teachers is significant at $p < 0.01$

1 School participation rate before including replacement schools is below 85%

2 School participation rate after including replacement schools is below 85%

3 Teacher participation data were collected after survey administration

4 Nationally defined population covers less than 90% of the nationally desired population.

6.1.3 Teachers' qualifications

It is generally expected that teachers with higher academic qualifications have better mastery of subject-matter knowledge and possibly pedagogical knowledge and skills as well. Two of the questions in the teacher survey asked for information about teachers' qualifications: the first concerned the highest academic qualification achieved; the second asked if the teacher possessed a teaching license.

Before describing the findings related to teachers' qualifications, we caution readers not to make cross-system comparisons with this data due to the widely varying situations and interpretations of qualification titles in the different systems. Furthermore, within any one country, the higher education and/or teacher education system may have changed over the years, particularly as a result of the implementation of the Bologna Agreement signed by EU countries in 1999 to establish a European Higher Education Area by 2010. Hence, the meanings of different qualifications can differ even for teachers in the same system, depending on when they received their qualifications.

For example, in Denmark, teacher training does not take place at universities but at special teacher-training colleges. Danish teachers who began their teacher training before 2001 were not awarded bachelor degrees, but received a qualification at ISCED level 5B (OECD, 1999). In 2001, teacher training for primary and lower-secondary schools changed, and teachers who have entered teacher training since then receive a (non-university) bachelor in education. In Russia, teachers qualified before implementation of the Bologna Agreement possess a "post-secondary education" (e.g., at teachers' college). This means they graduated with a teacher diploma of middle professional education from a three- to four-year post-secondary professional education facility in a teacher training school after having completed a general secondary education, which is roughly equivalent to a bachelor's degree. "Bachelor's degree" and "master's degree or above" awarded in Russia before the Bologna Agreement are roughly equivalent to a master's degree or doctoral degree respectively in their current nomenclature.

a. Highest level of academic qualification achieved

Table 6.3 presents the numbers of mathematics teachers with different educational qualifications and the percentage in each qualification category who reported using ICT when teaching the target class. In the survey question, teachers could respond to four categories of educational qualification: secondary or high school, post-secondary education (e.g., teachers' college), bachelor's degree, and master's degree or above. Because the number of teachers with only a secondary or high-school education was either nil or very small, we collapsed the two categories secondary or high school and post-secondary education into one category (see Table 6.3).

The results presented in Table 6.3 indicate that the highest percentage of ICT-using teachers were generally more likely to be found in the highest qualification category *master's degree or above*. However, in many cases, the number of teachers in one or two qualification categories was very small, making statistical interpretation of the difference non-feasible. For example, of the 1,232 mathematics teachers in the Russian Federation who responded to the questionnaire, only 16 reported their highest qualification to be teachers' college or below and only 44 reported having a master's degree or above. For science teachers, the pattern was similar to that of the mathematics teachers. In the interest of space, we do not report detailed statistics here. Interested readers can access this information from Table W6.3S in the online appendix http://www.sites2006.net/appendix.

b. Possession of a teaching license

While the highest level of academic qualifications achieved by the teacher is an indication of the general level of education reached, the possession or otherwise of a teaching license indicates whether the teacher has received a professional qualification for teaching. However, as is the case with general academic qualifications, the meaning of a teaching license may differ across systems. In the Russian Federation, no one is permitted to teach without a teacher's diploma. Having a teacher's *license* in addition to the teacher's diploma in Russia is rewarded with higher salaries. Candidates gain the license by going through a special attestation procedure in which they must prove, through evidence such as attendance at post-graduate courses and high student-achievement results, that they have reached over the previous five years a high standard of teaching quality. Application for a teacher's license is not obligatory, however, and teachers have only one chance every five years to improve their salaries.

Table 6.3 Number of mathematics teachers with different educational qualifications and the percentage of teachers in each qualification category who had used ICT with their target classes

Education system	Teachers' college or lower		Bachelor's degree		Master's degree or above		System mean
	N	use ICT %	*N*	use ICT %	*N*	use ICT %	
Catalonia, Spain	182	29 (0.04)	435	42 (0.02)	46	44 (0.08)	38 (2.02)
[1] Chile	34	55 (0.10)	479	55 (0.02)	32	78 (0.08)	56 (2.14)
Chinese Taipei	7	34 (0.19)	621	31 (0.02)	220	47 (0.03)	35 (1.63)
[2] Finland	19	64 (0.13)	151	38 (0.05)	383	50 (0.03)	48 (2.54)
[2] Hong Kong SAR	56	68 (0.06)	381	69 (0.03)	127	74 (0.04)	70 (2.15)
[4] Israel	79	27 (0.06)	514	21 (0.02)	248	23 (0.03)	22 (1.58)
[1] Italy	–	–	613	57 (0.02)	40	64 (0.08)	57 (2.07)
[1, 3] Japan	5	19 (0.15)	429	22 (0.02)	32	32 (0.08)	23 (1.92)
[2] Ontario Province, Canada	44	78 (0.06)	294	74 (0.03)	55	78 (0.05)	75 (2.33)
Singapore	31	90 (0.05)	408	72 (0.02)	39	77 (0.07)	73 (1.84)
Slovak Republic	6	65 (0.20)	–	–	552	51 (0.02)	51 (2.23)
Slovenia	429	36 (0.03)	282	46 (0.03)	4	45 (0.32)	40 (1.98)
†, 2 Alberta Province, Canada	1	0 (0.00)	296	63 (0.03)	58	59 (0.06)	62 (2.47)
# Denmark	303	78 (0.02)	31	66 (0.08)	13	69 (0.13)	77 (2.20)
# Estonia	16	44 (0.12)	182	39 (0.04)	37	43 (0.08)	40 (3.49)
# France	220	48 (0.03)	149	50 (0.04)	41	54 (0.09)	49 (2.56)
†, 2 Lithuania	13	29 (0.12)	246	62 (0.04)	117	67 (0.05)	62 (2.75)
† Moscow, Russian Federation	5	62 (0.22)	559	45 (0.02)	31	44 (0.10)	45 (2.35)
# Norway	31	75 (0.08)	213	81 (0.03)	49	80 (0.06)	80 (2.33)
† Russian Federation	16	57 (0.23)	1172	41 (0.03)	44	27 (0.13)	41 (3.47)
† South Africa	282	20 (0.03)	142	16 (0.03)	72	14 (0.04)	18 (1.97)
†, 1 Thailand	7	6 (0.09)	599	44 (0.03)	54	50 (0.08)	44 (2.56)

Notes:

Value labels for the response categories: 1=never, 2=sometimes, 3=often, 4=nearly always

\# School participation rate after including replacement schools is below 70%

† International procedures for target-class selection was not followed in all schools

[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Teacher participation data were collected after survey administration

[4] Nationally defined population covers less than 90% of the nationally desired population.

Data from the survey revealed that an overwhelming majority of the teachers surveyed possessed a teacher's license. In most systems, there were more teachers with a teaching license than without. Where the opposite pattern was observed, the number of teachers without a teaching license was so low that no interpretation could be made on statistical grounds. Because no substantive findings emerged from a detailed inspection of the descriptive statistics, these statistics are not reported here.

6.1.4 Teachers' self-reported technical and pedagogical competence in ICT-use

Teachers were asked to indicate their self-perceived levels of competence in both general and pedagogical uses of ICT. The specific competences included in the survey for each of the two kinds of ICT-competence are as follows:

Technical ICT competence:

- Word-processing
- Email
- Taking and displaying digital photos
- Filing electronic documents
- Using a spreadsheet
- Online discussion
- Producing an electronic presentation
- Online business transactions.

Pedagogical ICT competence:

- Preparation of lessons where students use ICT
- Knowledge of pedagogical situations suitable for ICT-use
- Finding useful curriculum resources on the internet
- Using the internet to support student learning
- Using ICT to monitor students' progress and evaluate students' learning outcomes
- Using ICT to give effective presentations
- Using ICT to collaborate with others.

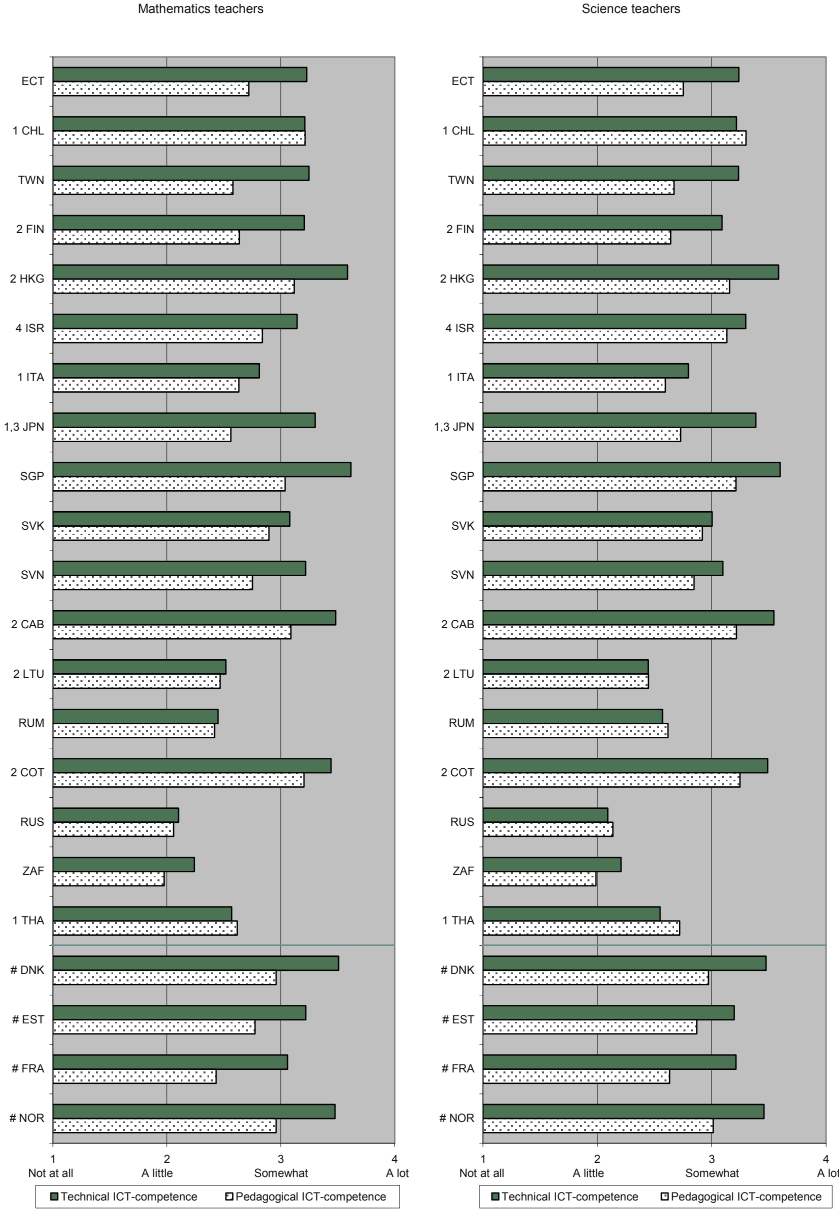
In regard to teachers' general use of ICT, the survey found that teachers considered themselves to be most competent in word-processing, electronic filing, and emailing (system means varying from 2.07 to 3.95 and from 2.06 to 3.96 for mathematics teachers and science teachers respectively). Teachers were least confident about sharing knowledge through online discussions (means from 1.46 to 3.36 and from 1.47 to 3.33 for mathematics teachers and science teachers respectively). Teachers' confidence in relation to their pedagogical use of ICT was highest for finding useful curriculum resources on the internet (means from 1.99 to 3.64 and from 2.02 to 3.68 for mathematics teachers and science teachers respectively) and lowest for using ICT in monitoring students' progress and evaluating learning outcomes (means from 1.96 to 2.94 and from 1.98 to 3.05 for mathematics teachers and science teachers respectively). Figure 6.1 presents the indicators for the teachers' technical and pedagogical ICT-competence computed as mean scores for each of the above two sets of items.

The obvious pattern in the figure relates to the considerable variation across systems in terms of the teachers' self-perceived technical and pedagogical ICT-competence. In most systems, teachers' self-perceived competence had a higher mean for general ICT-use than for pedagogical ICT-use, indicating that teachers were generally more confident about using ICT in everyday situations than in teaching and learning situations.

Systems with the highest reported technical ICT-competence do not exactly coincide with those having the highest reported pedagogical ICT-competence. Teachers from both teacher populations in Hong Kong and Singapore reported the highest levels of technical ICT-competence while those in Chile and Ontario reported the highest pedagogical ICT-competence. Teachers in South Africa and the Russian Federation reported the lowest levels of competence in both general and pedagogical ICT-use. In Japan, both teacher populations reported very high levels of technical ICT-competence but much less impressive pedagogical ICT-competence, resulting in the greatest observed gap between the mean levels of these two kinds of competence. These observations indicate that higher technical ICT-competence alone is not sufficient to build teachers' pedagogical competence in ICT-use. The widely varying difference between these two kinds of competences across systems is indicative of a factor that is probably strongly influenced by system-level policies and strategies.

It is fair to assume that a teacher's ICT-competence will affect his or her adoption of ICT-use in teaching and learning. Later in this chapter, we systematically explore (using binary logistic regression) this relationship, which we anticipated would show cross-national variation, for each participating system.

Figure 6.1 Mathematics teachers' and science teachers' self-reported technical and pedagogical ICT-competence



Notes:
#School participation rate after including replacement schools is below 70%
[1]School participation rate before including replacement schools is below 85%
[2]School participation rate after including replacement schools is below 85%
[3]Teacher participation data were collected after survey administration
[4]Nationally defined population covers less than 90% of the nationally desired population.

We next sought to determine if any relationship could be discerned between the mean levels of self-perceived competence and the mean levels of ICT-use by teachers at the system level. Figure 6.2 shows scatterplots of the percentage of ICT-using mathematics teachers relative to the mean levels of their self-reported technical and pedagogical ICT-competence for all participating systems. As we can see from the figure, the scatterplot for pedagogical ICT-competence shows a clearer and stronger relationship with the percentage of ICT-using teachers than does the scatterplot for technical ICT-competence. Space constraints mean that we could not include the corresponding scatterplots for science teachers (which can be found in Figure W6.2S at http://www.sites2006.net/appendix). However, the pattern of relationship for these teachers was similar to that for the mathematics teachers.

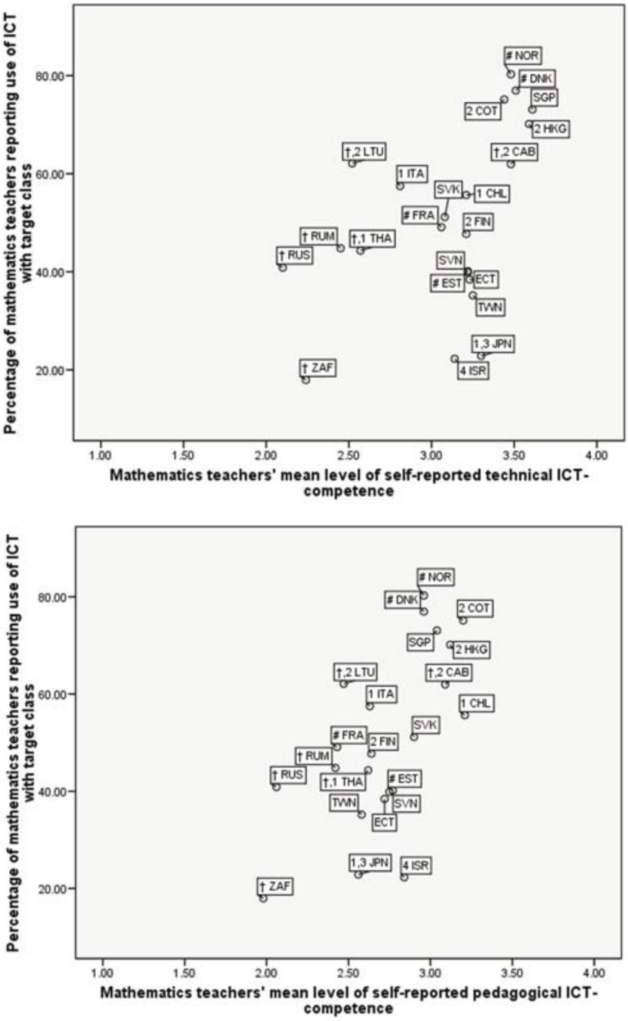
6.2 Organizational and system-level conditions influencing ICT-use

The teacher questionnaire included a number of questions that aimed to find out about teachers' experiences in relation to several organizational and system-level factors: participation in ICT-related professional development activities (ICT-PD), teachers' perceptions of the extent of existence of various obstacles to ICT-use, and the presence of features indicative of a community of practice in the teachers' schools. These factors cannot be distinguished unambiguously as either organizational or system-level because of the complex interactions teachers typically have with system- and school-level conditions. For example, teachers' participation in ICT-PD is conditional on their availability, which may be provided at school, regional, and/or system levels. Conversely, a teacher's participation in ICT-PD is a personal response to availability as a contextual factor. Hence, teachers of the same subject in the same school may have responded differently to this same question. This section reports our findings from the responses to these questions.

6.2.1 Teachers' attendance and desire to participate in ICT-related professional development activities

The provision of ICT-PD activities is a major means of improving teachers' competence and confidence in using ICT in their teaching. The questionnaire asked teachers whether they had attended, and if not, whether they wanted to attend, seven ICT-PD activities, five of which were technically oriented and two pedagogical (see Box 6.1).

Figure 6.2 Scatterplots of percentages of mathematics teachers' reported use of ICT with their target class and their mean levels of self-reported technical and pedagogical ICT-competence



Notes:
Value labels for the response categories: 1=not at all, 2=a little, 3=somewhat, 4=a lot
[#]School participation rate after including replacement schools is below 70%
[†]International procedures for target-class selection were not followed in all schools
[1]School participation rate before including replacement schools is below 85%
[2]School participation rate after including replacement schools is below 85%
[3]Teacher participation data were collected after survey administration
[4]Nationally defined population covers less than 90% of the nationally desired population.

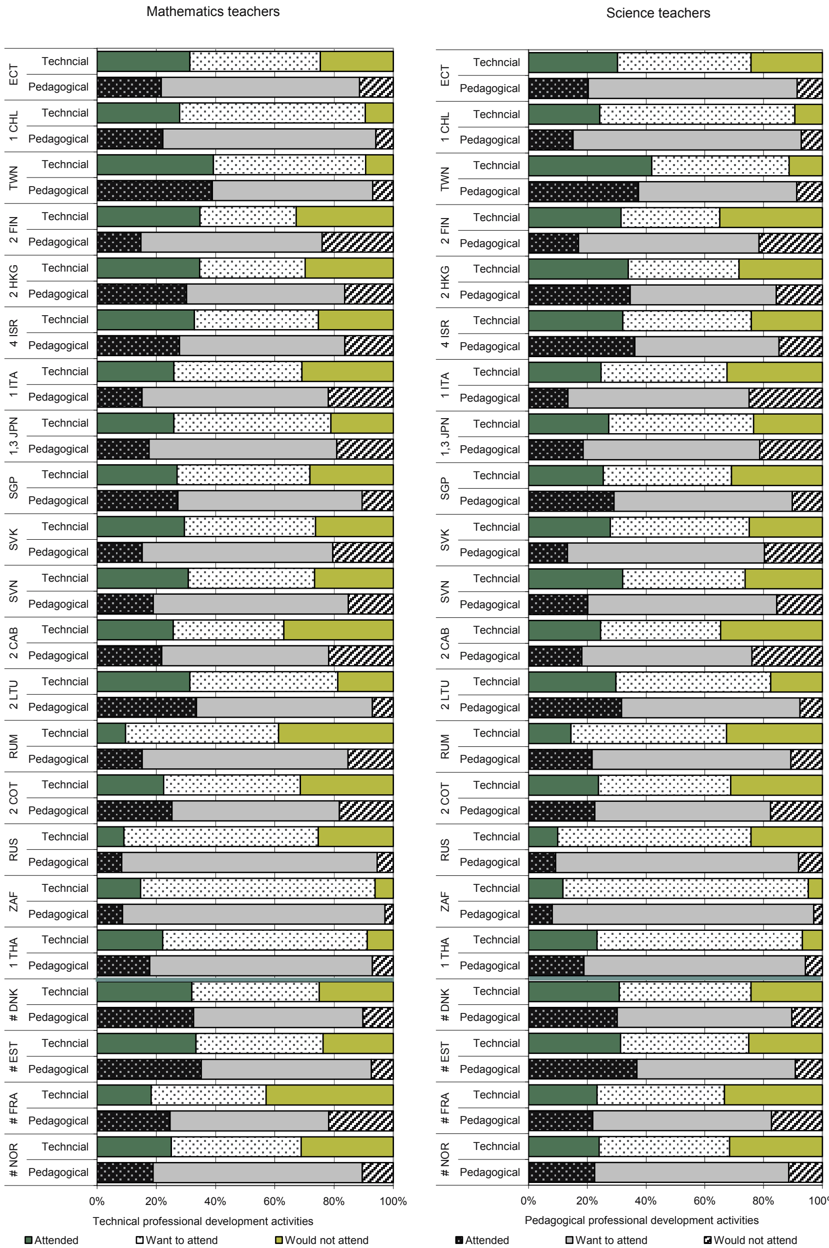
Box 6.1 Technical and pedagogical professional development activities listed in the teacher questionnaire

Type of PD activity	Specific activities listed
Technical	• Introductory course for internet use and general applications • Technical course for operating and maintaining computer systems • Advanced course for applications/standard tools • Advanced course for internet use • Course on multimedia operations
Pedagogical	• Course on pedagogical issues related to integrating ICT into teaching and learning • Subject-specific training with learning software for specific content goals

Figure 6.3 presents the survey results for the teachers' participation in ICT-PD. Just as the percentage of teachers reporting having used ICT in their teaching varied greatly across education systems, so too did the percentage of teachers who reported having attended ICT-PD. The highest attendance percentages (at about 40%) were reported in Chinese Taipei for both mathematics and science teachers in both general and pedagogical types of ICT-PD activities. The lowest attendance in the area of pedagogical ICT-PD was reported in South Africa and the Russian Federation (approximately 8% for South Africa and 9% for Russia). Although attendance in general ICT-PD in these two countries was slightly higher, it still represented the lowest level of attendance among the participating systems. The desire to participate in both types of professional development activities, however, was highest in those systems with the lowest attendance, indicating that the low attendance rates in these countries were not because the teachers did not want to attend, but due to limited course availability.

On comparing the percentages of teachers who had attended the two kinds of ICT-PD within each system, we found that, in most cases, the percentages were higher for technical than for pedagogical PD activities. System exceptions included Chinese Taipei, Singapore, Lithuania, Moscow, and Ontario-Canada for mathematics teachers and Hong Kong, Israel, Singapore, Lithuania, and Moscow for science teachers.

Figure 6.3 Teachers' participation in professional development activities



Notes:
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2School participation rate after including replacement schools is below 85%
3Teacher participation data were collected after survey administration
4Nationally defined population covers less than 90% of the nationally desired population.

The results presented in Figure 6.3 also indicate that, in some systems, relatively high percentages of teachers did not want to attend ICT-PD, particularly if it involved technical activities. The highest percentages reached about 40% for mathematics teachers in Alberta and Moscow and around 35% for science teachers in Alberta and Finland. The percentage of teachers who did not want to participate in pedagogical ICT-PD was much lower, mostly at less than 20%, except for mathematics teachers in Alberta, Finland, Italy, and the Slovak Republic and science teachers in Alberta, Finland, Italy, Japan, and the Slovak Republic. Across all systems, teachers were always more reluctant to attend technical ICT-PD than pedagogical ICT-PD. The observed difference in the percentages of teachers who did not want to participate in technical versus pedagogical ICT-PD was highest (at more than 20%) for mathematics teachers in Moscow and Norway and for science teachers in Singapore and Moscow.

Although PD attendance is influenced by whether teachers want to participate, availability of suitable PD activities is also, as noted above, a determining factor. In those systems where the attendance rate and the percentage who did not want to participate were both low, the availability of ICT-PD was low. Further, the percentage who did not want to participate was always lower for pedagogical than for technical ICT-PD but the actual attendance rate was normally lower for pedagogical ICT-PD. Thus, in many systems, technical ICT-PD appears to have been more available than pedagogical, although the demand for each was often the reverse. The availability and perceived desirability of ICT-PD is an important policy concern and should be investigated further at the system level.

6.2.2 Obstacles to pedagogical ICT-use as perceived by teachers

The teachers were asked to indicate whether they had experienced, when teaching, any of 12 listed obstacles to ICT-use. We grouped these obstacles into three categories: school-related factors pertaining to school culture or ICT resources available; teacher-related factors pertaining to competence, confidence, and time availability; and student-related factors pertaining to students' level of ICT-skills and access to ICT outside school. Box 6.2 gives a summary of these categories.

Box 6.2 The three categories of obstacles experienced by teachers in their use of ICT in teaching

Category of obstacles	Specific obstacle included within each category
School-related	• ICT is not considered useful in my school • My school does not have the required ICT-infrastructure • My school lacks digital learning resources • I do not have the flexibility to make my own decisions when planning lessons with ICT • I do not have access to ICT outside of the school
Teacher-related	• Lack of ICT-related skills • Lack of ICT-related pedagogical skills • Insufficient confidence to try new approaches alone • Lack of time to develop and implement ICT-using activities • Unable to identify which ICT tools will be useful
Student-related	• Students do not possess the required ICT-skills • Students do not have access to the required ICT-related tools outside of the school premises

Figure 6.4 shows the mean percentages of obstacles within each of the three categories that the mathematics teachers and science teachers in each system said they had experienced. The results differ greatly across the different systems, ranging from a maximum of 70% or more for student-related obstacles in South Africa, Thailand, and the Russian Federation to a low of about 20% in the same category in Slovenia. A comparison of the results obtained from the mathematics and the science teachers shows strong consistency within each system across the two teacher populations. Given that the sampling of the two populations of teachers was conducted on the same set of sampled schools, this strong similarity in the reported experience of obstacles (which is stronger than that for other reported characteristics such as teachers' ICT-competence across the teacher populations) indicates that the presence of these obstacles, including the student-related ones, had a strong association with the school context.

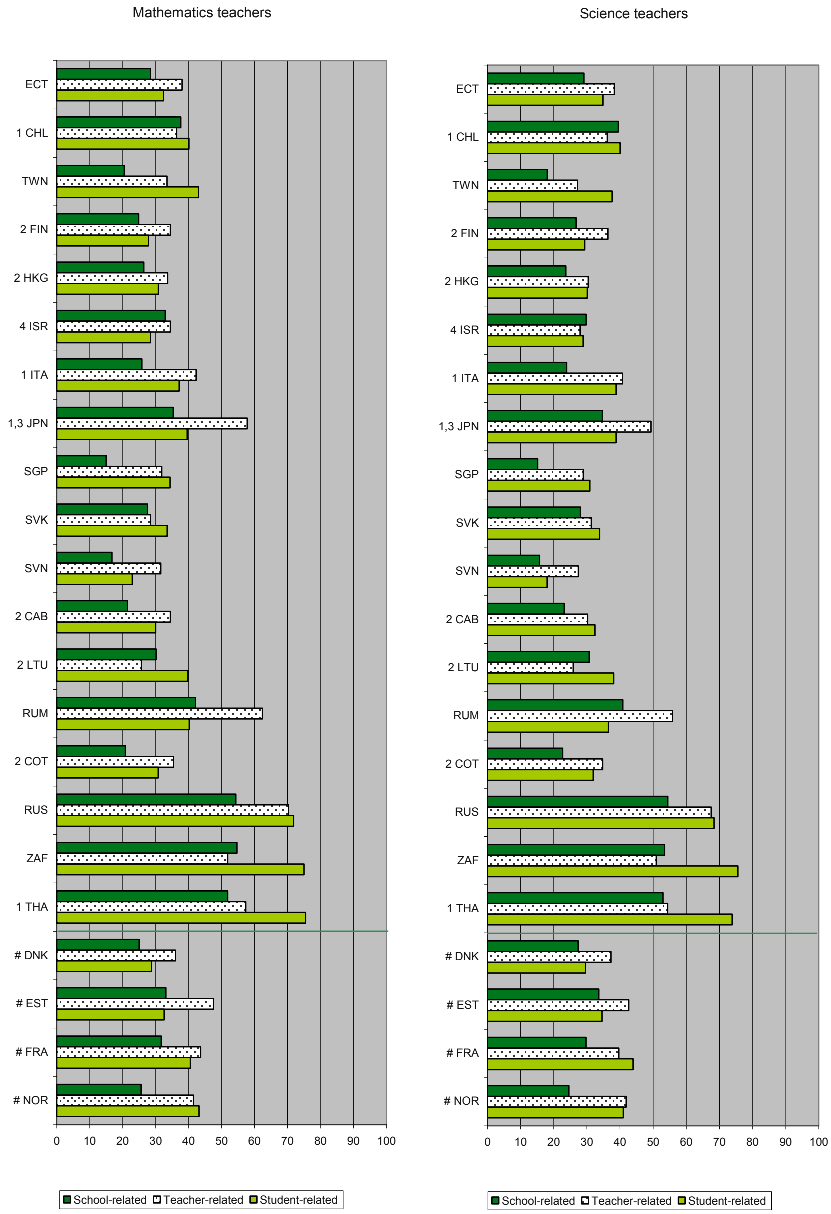
In general, the school-related obstacles were those least likely to be reported in most systems. The only exceptions were Chile and (to some extent) Israel. For most of the other systems, teacher-related obstacles were those most frequently reported. Fifty percent and above of both populations of teachers in Japan, Moscow, the Russian Federation, South Africa, and Thailand reported these obstacles. In three of these systems—the Russian Federation, South Africa, and Thailand—the levels of student-related obstacles reported were even higher, at around 70% or above. These varying patterns of obstacles indicate large diversities across systems in terms of the contextual factors influencing adoption of ICT.

The next part of our analysis sought an answer to this question: is there evidence that the mean level of obstacles experienced related in any way to the mean level of ICT-use by teachers at the system level? Figure 6.5 presents the scatterplots of the percentages of science teachers reporting use of ICT with their target classes against the mean percentages of the three categories of obstacles experienced by the teachers in the different systems (the corresponding scatterplots for mathematics teachers are presented in Figure W6.5M at http://www.sites2006.net/appendix). While the scatterplots do show a general negative slope, indicating that higher mean percentages of experienced obstacles were associated with a lower level of ICT-use by teachers with their target classes, closer inspection shows greater complexities, with some outliers strongly influencing the pattern in the scatterplots.

First of all, South Africa is an outlier in all three scatterplots, possibly due to the large percentage of schools without access to ICT-use for pedagogical purposes. Thailand and Russian Federation are also outliers in the scatterplots in terms of both school-related and student-related obstacles. If we do not take these outliers into account, different patterns emerge. With the school-related-obstacles pattern, we can still identify a negative trend, indicating that the mean level of school-related obstacles experienced at the system level correlates negatively with the overall level of pedagogical ICT-use by teachers in that system. Any efforts to increase ICT-use in teaching and learning should address such obstacles.

The scatterplot involving teacher-related obstacles has two more outliers in addition to the three identified above, namely Japan and Moscow, systems that reported exceptionally high percentages of teacher-related obstacles at levels comparable to those of South Africa. If we remove these five systems from consideration, no identifiable pattern can be discerned in the scatterplot. Thus, even if the level of teacher-related obstacles experienced correlates with teachers' pedagogical adoption of ICT, this would not emerge as a system-level trend on a scatterplot because of other confounding factors that also operate at a system level.

Figure 6.4 Mean percentages of obstacles within each of the three categories that mathematics teachers and science teachers reported experiencing



Notes:

#School participation rate after including replacement schools is below 70%

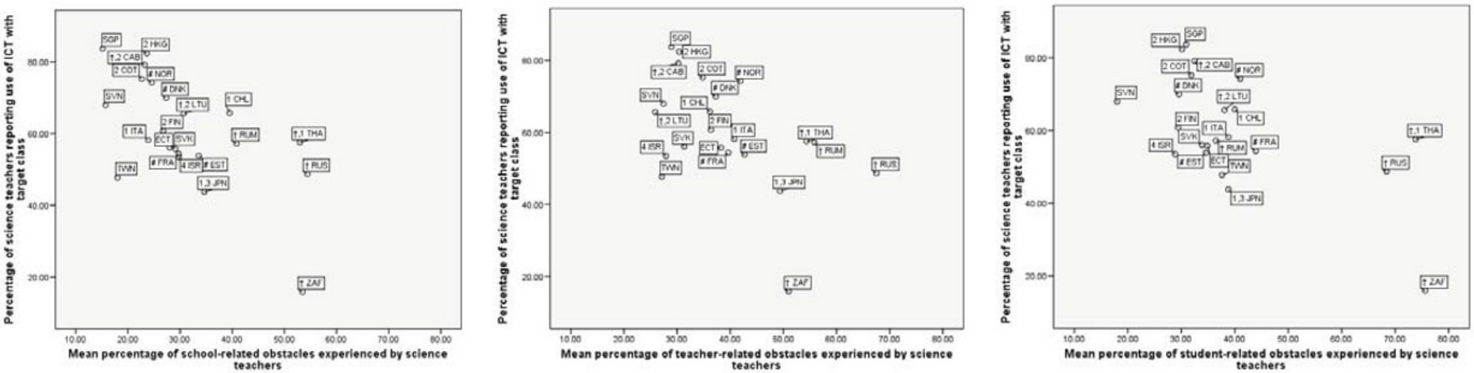
[1]School participation rate before including replacement schools is below 85%

[2]School participation rate after including replacement schools is below 85%

[3]Teacher participation data were collected after survey administration

[4]Nationally defined population covers less than 90% of the nationally desired population.

Figure 6.5 Scatterplots of the percentages of science teachers' reported use of ICT with their target class versus the mean percentages of each of the three kinds of obstacles experienced by science teachers when using ICT in the participating systems



Notes:
#School participation rate after including replacement schools is below 70%
†International procedures for target-class selection were not followed in all schools
[1]School participation rate before including replacement schools is below 85%
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When, for the scatterplot involving student-related obstacles, the three outlier systems Thailand, the Russian Federation, and South Africa are removed from consideration, we again see no observable pattern. Our exploration of the relationship between the extent to which the teachers experienced the various obstacles and their reported levels of ICT-use in teaching and learning within each system is reported later in this chapter.

6.2.3 Presence of a community of practice in the school as perceived by teachers

The presence of a community of practice (COP) is often considered an important factor supporting pedagogical innovation and change in schools (see, for example, Dexter, Seashore, & Anderson, 2002; Geijsel, Sleegers, van den Berg, & Kelchtermans, 2001). The idea underpinning this concept is that professionals such as teachers work with fellow professionals in an institutional context. Teachers' beliefs and practices are therefore strongly influenced by the cultures and practices of the organizational setting within which they operate.

Four key aspects can be identified in the literature pertaining to the presence of a COP for teachers. The first is whether teachers and the school's leadership have a shared vision. Because vision needs to be implemented through concrete policies, strategies, and plans, the second aspect centers on whether teachers are able to participate in the school's decision-making processes. When the focus within the school is on innovation and reform, there is always an element of risk, and the pressure is on teachers to justify the need for change and to develop the necessary resources and expertise for implementing the change. The presence of a strong culture for professional collaboration—generally considered conducive to change and innovation—therefore constitutes the third aspect. The fourth aspect, availability of technical, administrative, and infrastructural support, is also crucial to the establishment of a COP for ICT-implementation in a school. Box 6.3 lists the statements included in the teacher survey used to identify the presence of these four aspects of COP for ICT-supported pedagogical innovations.

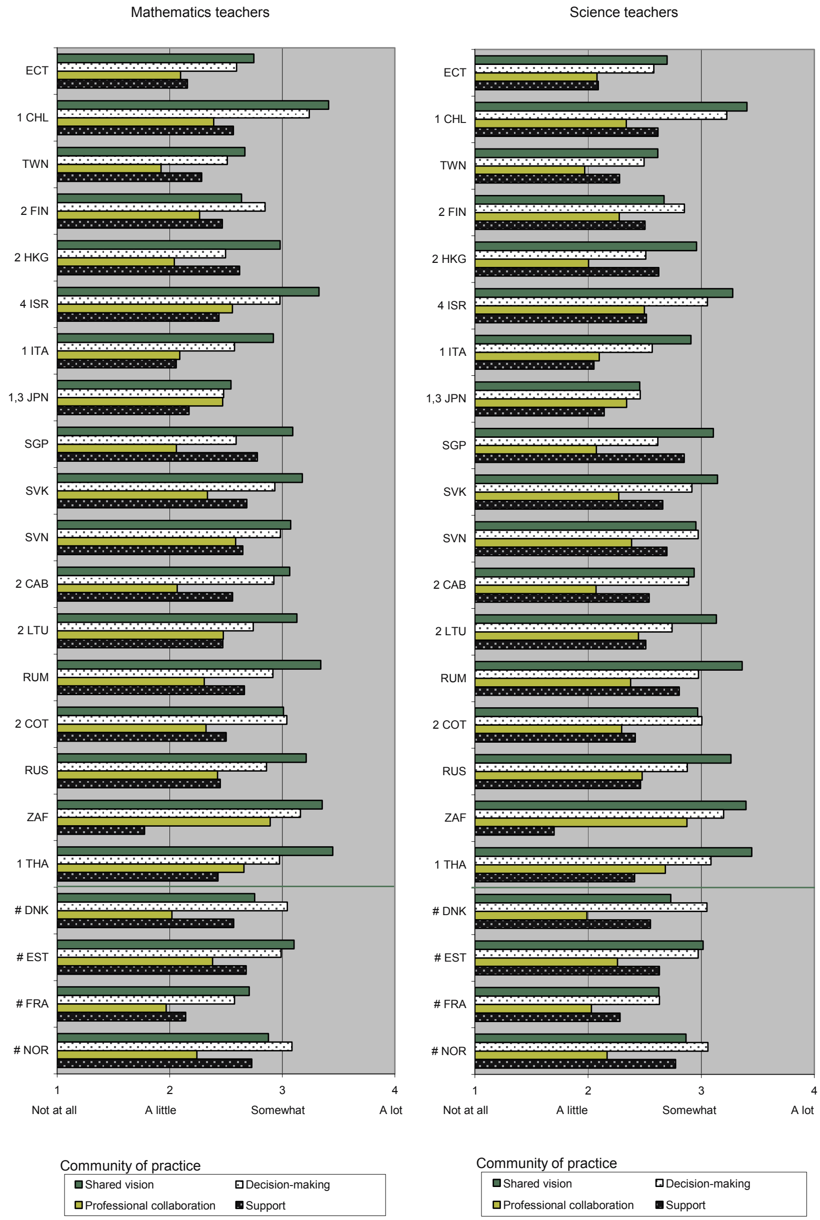
Box 6.3 Different aspects of the presence of a community of practice in schools

Community of practice aspects	Specific statements listed
School vision	• Teachers discuss what they want to achieve through their lessons • Teachers are constantly motivated to critically assess their own educational practices • Teachers are expected to think about the school vision and strategies with regard to educational practices
Decision- making	• Teachers can influence the development of the school-innovation implementation plans • When implementing innovations, the school considers teachers' opinions • Teachers are able to implement innovations in their classrooms according to their own judgment and insights
Professional collaboration	• Teacher co-teaches with colleagues • Teacher discusses problems experienced at work with colleagues • Teacher works with teachers in other schools on collaborative activities • Teacher works with teachers in other countries on collaborative activities
Support	• Teacher receives sufficient technical support from the school/region/state • Students can access computers easily outside scheduled class time without the teacher's help • Administrative work arising from ICT-use in teaching is easy to do

Figure 6.6 summarizes the extent to which both teacher populations in all participating systems saw their respective schools as having a COP. As the figure shows, shared vision was generally the aspect with the strongest perceived presence, with means ranging from 2.54 to 3.45 and from 2.46 to 3.45 for mathematics teachers and science teachers respectively. However, both populations of teachers in the three Nordic countries—Denmark, Finland, and Norway—differed from their international colleagues by giving their highest presence ratings to decision-making.

Professional collaboration had the lowest perceived presence in most systems, with the lowest mean scores (below 2.00) reported by both teacher populations in Chinese Taipei. The reported presence of professional collaboration was highest for mathematics teachers in Israel, Slovenia, South Africa, and Thailand, and for science teachers in Israel, South Africa, and Thailand. Here, all mean scores were above 2.5.

Figure 6.6 Mathematics teachers' and science teachers' perceptions of presence of different aspects of a community of practice in their schools



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In most systems, the presence of the support aspect of COP was not as marked as that of shared vision and decision-making, but it was more evident than professional collaboration. Singapore had the highest percentages of both mathematics and science teachers reporting the presence of support. The teachers gave their lowest presence ratings to support in only a few systems; they were the mathematics teachers in Israel and both sets of teachers in Italy, Japan, South Africa, and Thailand. The lowest level of support was reported in South Africa, the only system to register a mean score lower than 2 (="a little" on the Likert scale).

As with the other relationships highlighted in this chapter, we again used binary logistic regression analysis to explore the relationship between the perceived presence of COP and the teachers' pedagogical adoption of ICT within each system. The results of this analysis are set out in the following section of this chapter.

6.3 Further explorations of factors influencing teachers' use of ICT

In the previous two sections, we reported on the teachers' characteristics and their perceptions of various organizational- and system-level conditions. For categorical data such as gender and academic qualifications of the teacher, our discussion also included a comparison of the percentages of ICT-using teachers within the different response categories in the participating systems. Here, we report our explorations of the relationship within each system between teacher-reported factors that are continuous variables and the teachers' use of ICT when teaching the target class. The continuous variables included self-reported technical and pedagogical ICT-competence, participation in technical- and pedagogical-ICT, obstacles experienced, and the perceived presence of the four aspects of COP in the school.

Whether teachers had actually used ICT at least once in teaching the target class is a binary variable (i.e., the answer can only be yes or no), which meant we could not apply ordinary regression to explore the relationship and so had to adopt binary logistic regression—a technique for predicting the mean value of a binary response variable (such as yes/no responses)—as a function of one or more covariates. This section reports only the *findings* from the analysis. Readers interested in understanding more about its technical details are referred to Appendix A. Also, space constraints mean that Table 6.4 presents only the binary logistic regression results for mathematics teachers (results for science teachers can be found in Table W6.4S at http://www.sites2006.net/appendix). We discuss the results separately for each group of factors, despite having performed the analysis by fitting all the variables into the model at one time.

6.3.1 Teachers' ICT-competence

Two self-reported ICT-competence scores, technical and pedagogical, were included in the binary logistic regression analysis. From Table 6.4, we can see that Hong Kong and Japan were exceptional in that neither the technical nor the pedagogical ICT-competence of the teacher was a statistically significant predictor of teachers' reported use of ICT with their target class. This finding may relate to the rather high levels of teachers' self-reported ICT-competence in both areas in Hong Kong and Japan. For all other participating systems, at least one self-perceived ICT-competence score was a statistically significant predictor of teachers' reported pedagogical use of ICT, indicating that ICT-competence and teachers' use of ICT are generally significantly associated.

In most systems, both self-reported ICT-competence scores were statistically significant predictors of teachers' pedagogical adoption of ICT; the strength of the association was higher for pedagogical ICT-competence than for the respective technical ICT-competence. In the remaining systems, only one of the two ICT-competence scores was a statistically significant predictor and that was always pedagogical ICT-competence.

To conclude, we found pedagogical ICT-competence was a positive predictor of teachers' pedagogical adoption of ICT in all but two of the participating systems. However, a similar positive correlate for technical ICT-competence emerged in only a third of the participating systems.

6.3.2 Attendance in ICT-related professional development activities

Table 6.4 also includes the analysis results for the two predictor variables on attendance in technical and pedagogical ICT-PD. The results indicate that, in most systems, the level of attendance in technical ICT-PD was not a statistically significant predictor of whether a teacher adopted ICT in his or her teaching. In the eight systems where the level of attendance in technical ICT-PD was a statistically significant predictor, only Italy and Thailand showed a strong positive association.

Table 6.4 Odds ratios and the levels of statistical significance emerging from the binary logistics regression analysis of the relationship between personal and contextual factors (as perceived by mathematics teachers) and mathematics teachers' pedagogical ICT-use

Education system	ICT-competence		Community of practice				Professional development		Obstacle			Constant
	Technical	Pedagogical	Shared vision	Decision-making	Professional collaboration	Support	ICT	Pedagogical	School-related	Teacher-related	Student-related	
Catalonia, Spain	0.82	1.97 **	0.51 **	1.85 **	0.83	1.38 **	1.37	1.24	0.30 **	0.18 **	1.07	0.36 *
[1] Chile	0.53 **	4.65 **	0.88	1.10	1.57 **	2.02 **	0.38 **	2.75 **	2.02 **	0.15 **	1.42 **	0.01 **
Chinese Taipei	0.63 **	1.69 **	0.82 **	0.82 **	2.30 **	1.02	1.14	2.00 **	0.66 *	0.32 **	1.10	0.36 **
[2] Finland	1.23	1.72 **	0.77 *	1.27 *	0.97	1.11	0.85	2.58 **	0.15 **	0.80	1.40 *	0.13 **
[2] Hong Kong SAR	1.22	1.11	1.04	1.01	0.91	1.83 **	1.12	0.67	0.80	0.41 **	2.62 **	0.22 **
[4] Israel	0.52 **	2.16 **	0.76 *	1.03	1.09	1.55 **	0.60 *	1.78 **	0.53 *	0.28 **	1.63 **	0.22 **
[1] Italy	1.18 **	2.59 **	0.81 **	0.98	0.99	2.26 **	19.29 **	1.50 **	0.60 **	0.27 **	0.73 **	0.04 **
[1, 3] Japan	1.07	1.03	0.94	1.23 **	1.20 **	1.29 **	0.80 *	2.33 **	0.52 **	0.21 **	0.81 **	0.15 **
[2] Ontario Province, Canada	0.93	2.08 **	1.24 **	1.27 **	0.92	1.07	0.89	4.14 **	0.80	0.29 **	0.97	0.16 **
Singapore	0.79	2.17 **	0.92	1.27	0.60 *	1.55 *	1.20	1.33	0.41	0.56	0.87	0.56
Slovak Republic	1.55 **	3.18 **	0.69 **	0.99	0.71 *	1.66 **	1.42	1.57	0.84	0.52 *	0.84	0.02 **
Slovenia	0.73	2.79 **	0.79	1.37 *	0.87	1.28 *	1.27	1.54	0.10 **	0.37 **	2.28 **	0.08 **
[†, 2] Alberta Province, Canada	0.92	2.49 **	1.12	0.82	0.87	0.99	1.00	2.69 **	0.11 **	0.78	1.68 *	0.30
[#] Denmark	0.73 *	1.57 **	0.66 **	0.97	1.80 **	1.37 **	0.98	2.21 **	0.96	0.28 **	0.72 *	2.02
[#] Estonia	1.72 *	4.15 **	1.08	1.59	0.96	1.09	0.43	1.29	0.23 **	1.12	0.80	0.00 **
[#] France	1.24 **	1.12 **	0.57 **	1.14 **	1.34 **	0.77 **	1.14	1.08	0.07 **	0.04 **	1.48 **	9.87 **
[†, 2] Lithuania	1.94 **	1.64 **	0.77	1.62 **	0.94	1.27	0.47 *	2.26 **	0.19 **	0.54 *	0.69 *	0.10 **
[†] Moscow, Russian Federation	1.29	2.97 **	0.75 *	1.19	1.32	1.68 **	0.85	1.09	0.38 **	1.17	0.66 *	0.01 **
[#] Norway	2.63 **	0.57 **	1.24	1.18	1.10	1.36 *	1.59	1.34	0.12 **	0.31 **	2.24 **	0.18 *
[†] Russian Federation	1.46 **	2.20 **	0.65 **	1.57 **	0.90 **	2.02 **	0.24 **	1.08	0.67 **	1.35 **	1.39 **	0.01 **
[†] South Africa	0.70 **	1.42 **	0.82 **	1.39 **	0.77 **	1.22 **	0.13 **	8.73 **	0.47 **	0.76	0.69 **	0.55 *
[†, 1] Thailand	0.64 **	4.91 **	0.61 **	1.39 **	0.98	1.69 **	1.47 **	1.24 *	0.48 **	1.03	1.14	0.02 **

Notes:

[#] School participation rate after including replacement schools is below 70%
[†] International procedures for target-class selection was not followed in all schools
[1] School participation rate before including replacement schools is below 85%
[2] School participation rate after including replacement schools is below 85%
[3] Teacher participation data were collected after survey administration
[4] Nationally defined population covers less than 90% of the nationally desired population.
[*] Significant at $p < 0.05$
[**] Significant at $p < 0.01$.

6.3.3 Obstacles to adopting ICT in teaching

Indicators for the extent of school-related, teacher-related, and student-related obstacles reported by teachers were also included in the binary logistic regression analysis. According to the results, both school-related and teacher-related obstacles were statistically significant negative predictors of teachers' use of ICT in teaching and learning, although the magnitude of the association differed from system to system. In some systems such as Slovenia and Finland, the level of school-related obstacles experienced was a very strong negative predictor while in other systems such as Catalonia, Chile, and Japan, the level of teacher-related obstacles experienced was a very strong negative predictor. In about half of the participating systems, the analysis results showed that both kinds of obstacles were statistically significant negative predictors of teachers' likelihood of adopting ICT in their teaching. In most of the remaining systems, one of these two kinds of obstacles was a statistically significant negative predictor. Singapore was exceptional in that neither type of obstacle was a statistically significant predictor of teachers' pedagogical adoption of ICT. The results for Chile were also unique and somewhat puzzling in that the level of school-related obstacles experienced by teachers was a statistically significant positive predictor for teachers' reported use of ICT in teaching.

As reported in section 6.2.2, school-related obstacles had the lowest means among these three obstacle-related indicators in a large majority of the 22 participating systems. The analysis results hence indicate that school-related factors are still important predictors for ICT-adoption in most systems, a consideration that aligns with the finding of a negative trend across systems between the mean level of school-related obstacles experienced within a system and the respective percentage of teachers in that system adopting ICT in their teaching. This pattern is consistent with findings from the literature which show that support at school level is important for reducing teachers' computer anxiety (Bradley & Russell, 1997) and in encouraging teachers to use ICT (Yuen, Law, & Wong, 2003).

The highest reported mean among the three categories of obstacles within a system was for either teacher-related or student-related obstacles. Student-related obstacles included in the survey pertained to the widening digital divide among students. The analysis results for student-related obstacles revealed a pattern very different from the patterns for the other two categories of obstacles. While the level of student-related obstacles experienced was a statistically significant predictor of teachers' use of ICT in teaching in 15 systems, it was a negative predictor in only six of those cases, and a positive predictor in the remaining nine. One interpretation of this counter-intuitive finding is that teachers reporting a higher level of student-related obstacles were more aware of the digital divide and hence more likely to make conscious efforts to use ICT in their teaching in order to reduce that divide.

Overall, the findings relating to obstacles show that the systems differed not only in the extent to which their teachers had experienced the different obstacles but also in the extent to which the teachers' experiences correlated with their pedagogical adoption of ICT. Both school- and teacher-related obstacles were significant negative predictors for most systems. Singapore was the only system for which none of the obstacles was a statistically significant predictor. At the other extreme were three systems for which all three categories of obstacles were significant negative predictors: Lithuania, Italy, and Japan.

6.3.4 Perceived presence of a community of practice

The research literature (examples cited previously) points to the presence of a community of practice (COP) as a positive factor contributing to pedagogical innovation because it provides teachers with a supportive organizational environment that is conducive to risk-taking and experimentation. Our binary logistic regression analysis included four indicators of the teachers' experience of a community of practice—a shared vision, participation in decision-making, professional collaboration, and support.

Of the four COP indicators, *shared vision* turned out to be a relatively weaker predictor and *support* a statistically significant positive predictor for a large majority of the participating systems. The next most important COP predictor of teachers' pedagogical adoption of ICT was *shared decision-making*, with this correlation being statistically significant and positive in about half of the participating systems.

There was no system in which all COP indicators were statistically significant and positive. Japan was the only country for which there were three positive and statistically significant COP indicators (only shared vision was not significant). For systems that had only one statistically significant positive COP indicator, that predictor was almost always support. Hence, support and shared decision-making emerged as the most important COP predictors of pedagogical ICT-adoption by teachers.

In summarizing the findings related to the various personal and contextual factors explored in this section, we found teachers' pedagogical ICT-competence, participation in pedagogical ICT-PD, support to teachers, and shared decision-making to be the most important positive predictors of use of ICT in teaching and learning. School-related and teacher-related obstacles were both negative predictors of ICT-use in teaching. Significant cross-system differences were evident in how the different personal and contextual factors correlated with teachers' ICT adoption in teaching. We also consider it likely that further analysis would reveal important interaction effects between the different personal and contextual factors and that these interactions would differ across the systems.

6.4 Teachers' pedagogical-practice orientations and their use of ICT in teaching

One important research question for the present study focused on whether the general pedagogical orientation of a teacher would influence the likelihood of him or her adopting ICT when teaching. We considered this to be another question that could be answered by conducting a binary logistic regression analysis, in this case with teachers' pedagogical use of ICT as the outcome variable and the core indicators of their pedagogical orientations as the predictor variables. As explained in Chapter 5, three sets of pedagogical orientation scores were computed from teachers' responses to three of the survey questions. The three sets of indicators cover curriculum goals, teacher practice, and student practice, and each set has three pedagogical orientations—traditionally important, lifelong learning, and connectedness, giving nine indicator scores for each teacher.

We anticipated that the binary logistic regression analysis findings would shed light on whether teachers' pedagogical adoption of ICT was indeed prioritized by their overall pedagogical orientations. We also considered that the findings would provide policymakers with useful information at a system level, particularly as to whether their strategies for encouraging ICT-use might have different levels of effectiveness, depending on teachers' pedagogical orientations.

The binary logistic regression analysis results for ICT-adoption by mathematics teachers on the nine pedagogical-orientation scores are presented in Table 6.5. For the three sets of traditionally important orientation scores (i.e., for curriculum goals, teacher practice, and student practice), only about half of the cases were statistically significant predictors and most of these were negative, indicating that where statistically significant relationships were found, teachers with a stronger traditionally important curriculum-goal orientation were those teachers least likely to have used ICT in their teaching.

For the lifelong learning pedagogical orientation, the results from the binary logistic regression analysis were more variable. The lifelong learning orientation scores for curriculum goal and teacher practice were mostly not significant predictors. In the cases where these were statistically significant, half were positive predictors and the other half were negative predictors. However, the lifelong-learning student-practice score was a statistically significant positive predictor of teachers' ICT use in 13 systems.

The three connectedness-related pedagogical-orientation scores were somewhat more consistent predictors of ICT-use than were the previous two sets of indicators. The connectedness scores for the goal-orientation teacher-practice score and the student-practice score emerged as statistically significant positive predictors of teachers' ICT-use in almost all systems. Thus, teachers with a stronger connectedness orientation were those teachers most likely to be using ICT in their teaching. Further, the connectedness scores for curriculum goal turned out to be the best predictor among the three connectedness indicators. Results for the science teachers are similar and the corresponding results can be found in Table W6.5S at http://www.sites2006.net/appendix.

In summary, the results indicate that, in most systems, teachers with a stronger traditionally important orientation were the teachers least likely to be using ICT in their teaching whereas those teachers with a stronger 21st-century orientation (i.e., the lifelong learning and connectedness orientations) were the teachers most likely to be using ICT in their teaching.

Table 6.5 Odds ratios for the nine pedagogical-orientation scores and the levels of statistical significance that emerged from the binary logistics regression analysis of mathematics teachers' pedagogical ICT-use

	Education system	Goal			Teachers practice			Students practice			Constant
		Traditionally important	Lifelong	Connectedness	Traditionally important	Lifelong	Connectedness	Complete exercises	Lifelong	Connectedness	
	Catalonia, Spain	0.74 *	0.55 **	3.09 **	0.61 **	1.54 **	0.80	1.06	0.98	1.15	1.41
1	Chile	0.95	1.09	1.60 **	1.45 **	1.06	1.01	0.84 **	1.56 **	1.27 **	0.02 **
	Chinese Taipei	0.91	0.92	1.48 **	0.77 **	1.07	1.41 **	1.13 *	1.80 **	1.36 **	0.06 **
2	Finland	1.05	0.79	1.53 **	0.76 **	0.75 *	1.33 *	1.08	1.96 **	1.71 *	0.20 **
2	Hong Kong SAR	1.07	0.95	1.45 **	1.02	0.87	0.98	1.48 **	1.71 **	0.62 **	0.24 *
4	Israel	1.20	0.95	1.40 **	0.85	1.15	1.45 **	0.90	1.12	1.35 **	0.03 **
1	Italy	0.44 **	1.15 *	2.42 **	0.71 **	0.69 **	0.76 **	0.95 *	1.91 **	1.18 **	3.80 **
1, 3	Japan	0.75 **	1.06	1.38 **	1.60 **	1.29 **	1.35 **	0.87 **	1.11	1.10	0.03 **
2	Ontario Province, Canada	0.91	1.14	1.66 **	1.67 **	1.01	0.92	0.34 **	2.04 **	0.94	0.69
	Singapore	1.37	1.11	1.62 *	1.52	1.18	0.71	0.80	1.57	1.00	0.06 **
	Slovak Republic	0.83	0.86	2.79 **	0.57 **	0.93	0.84	0.98	1.24	1.33 *	0.69
	Slovenia	0.99	0.75	1.66 **	0.77	1.30	0.80	1.01	0.93	2.81 **	0.26
†, 2	Alberta Province, Canada	0.96	0.74	2.10 **	0.63 **	1.33	0.98	0.85	1.29	0.76	3.04
#	Denmark	1.07	0.85	1.93 **	1.24	0.51 **	0.81	0.71 **	4.04 **	3.01 **	0.17 **
#	Estonia	1.01	1.12	1.16	1.04	1.10	1.14	0.78	1.15	1.23	0.16
#	France	0.68 **	1.39 **	1.21 **	1.28 **	0.48 **	0.92	0.66 **	3.99 **	1.10	0.75
†, 2	Lithuania	0.47 **	2.27 **	0.91	0.90	0.71 *	1.39 *	1.08	4.59 **	1.50 *	0.06 **
†	Moscow, Russian Federation	0.76	1.34	1.83 **	0.57 **	0.75	0.90	1.34 **	3.28 **	1.85 **	0.03 **
#	Norway	1.23	2.10 **	1.13	0.50 **	1.53 *	1.04	0.99	0.80	2.47 **	0.24 *
†	Russian Federation	0.62 **	0.97	2.13 **	0.61 **	1.36 **	0.64 **	1.53 **	2.26 **	1.30 **	0.10 **
†	South Africa	1.34 **	0.49 **	0.94	0.56 **	1.38 **	1.13	0.68 **	1.38 **	1.04	2.74 **
†, 1	Thailand	0.44 **	1.00	1.47 **	1.45 **	0.82 **	1.74 **	0.79 **	1.25 **	1.52 **	0.46 **

Notes:

[#] School participation rate after including replacement schools is below 70%
[†] International procedures for target-class selection was not followed in all schools
[1] School participation rate before including replacement schools is below 85%
[2] School participation rate after including replacement schools is below 85%
[3] Teacher participation data were collected after survey administration
[4] Nationally defined population covers less than 90% of the nationally desired population.
[*] Significant at $p < 0.05$
[**] Significant at $p < 0.01$.

6.5 Teachers' vision of pedagogical use of ICT in the future

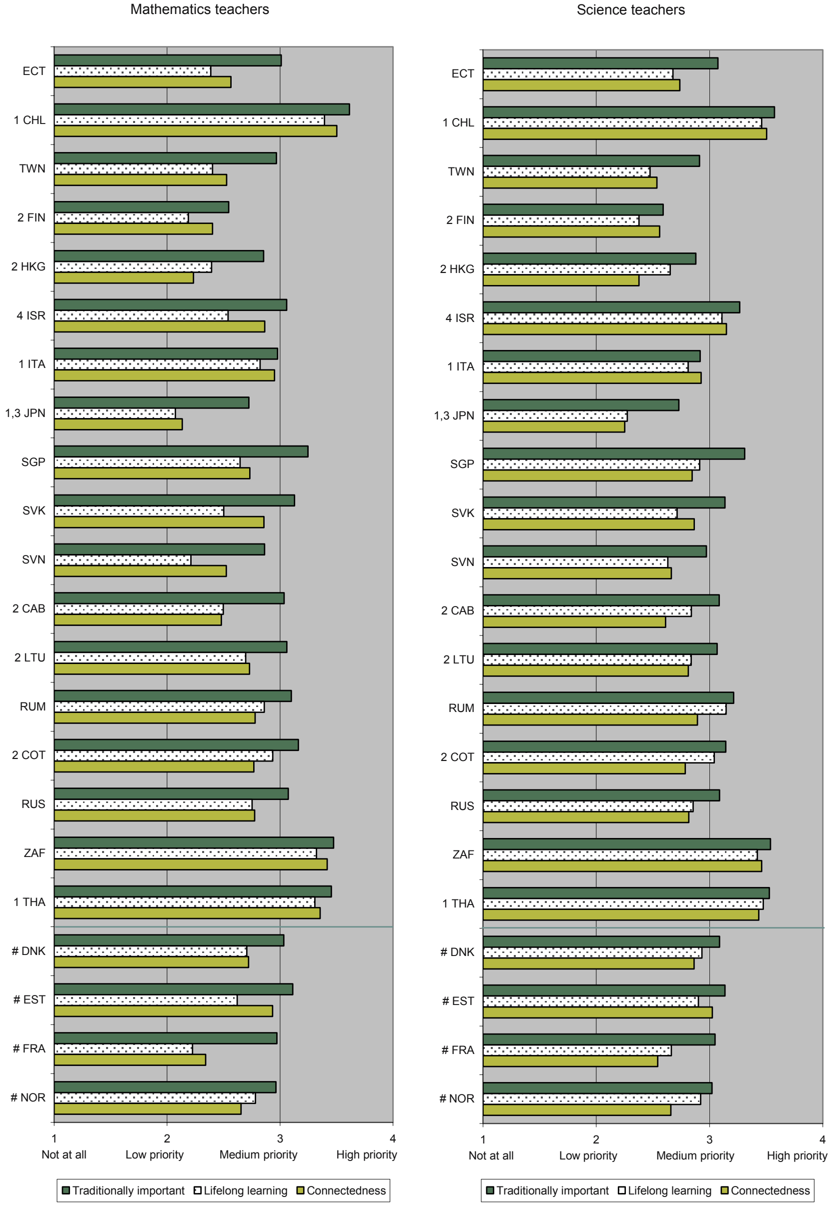
This study was also designed to gain some understanding of how teachers view anticipated pedagogical use of ICT in the future. The SITES research team considered that this understanding would help educators, policymakers, and decision-makers formulate policies and strategic implementation plans. Box 6.4 lists the priority areas for ICT-use given in the SITES teacher questionnaire, and groups these areas under the three pedagogical-practice orientations.

Box 6.4 Areas of priority for use of ICT in the next two years listed according to the pedagogical-practice orientations evident within these areas

Pedagogical orientation of teachers' vision	Area of priority for use of ICT
Traditionally important	• Monitor students' progress • Provide exercises to students so they can practice skills and procedures • Deliver better and more interesting lectures/presentations
Lifelong learning	• Provide activities to address students' individual differences • Arrange self-accessed activities for students • Engage students in multimedia production projects • Involve students in short collaborative projects • Involve students in extended collaborative projects • Involve students in scientific investigations
Connectedness	• Provide opportunities for students to collaborate with or learn from peers from other schools and from external experts • Collaborate with fellow teachers and others within and outside the school • Provide opportunities for students to collaborate with their classmates

Figure 6.7, which presents the mean levels of priorities that the teachers accorded ICT-use in the coming two years relative to each of the three pedagogical orientations, gives a clear insight into the teachers' visions for the near future. The results show the teacher populations within the same systems holding very similar visions. Also, comparison of Figures 5.6 and 5.7 highlights the fact that, in many systems, the vision for connectedness-oriented ICT-use had outpaced the connectedness orientation reported for ICT-using teacher- and student-practices for the academic year surveyed. This is an unambiguous and noteworthy indication of a growing awareness among teachers of the need to connect themselves and their students to peers and experts.

Figure 6.7 Association between mathematics teachers' and science teachers' pedagogical-practice orientations and their vision for ICT-use in the coming two years



Notes:

#School participation rate after including replacement schools is below 70%

[1]School participation rate before including replacement schools is below 85%

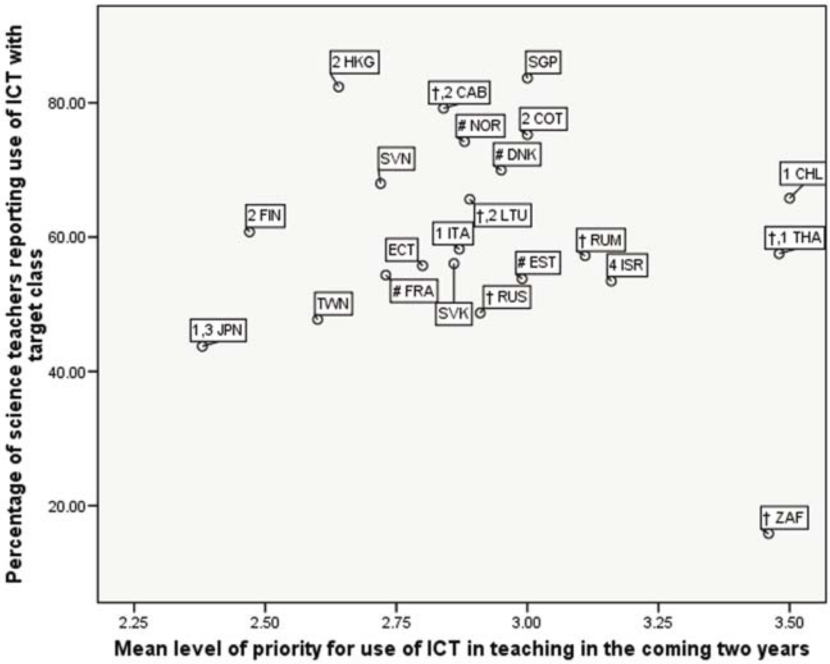
[2]School participation rate after including replacement schools is below 85%

[3]Teacher participation data were collected after survey administration

[4]Nationally defined population covers less than 90% of the nationally desired population.

The results presented in Figure 6.7 also indicate variation across systems in the mean level of priority that teachers gave to ICT-use in the coming two years (computed by taking the average of the priority scores for all three orientations). We accordingly asked ourselves whether, across systems, the mean priority for ICT-use in the coming two years related in any way to the level of ICT-use reported in the SITES survey. The results of our subsequent analysis, presented in Figure 6.8, which is a scatterplot of these two sets of statistics for science teachers, clearly indicated no relationship between these two parameters at a system level (results for mathematics teachers are similar and can be found online in Figure

Figure 6.8 Scatterplot of the percentage of science teachers reporting using ICT with their target class relative to their mean-reported priority for ICT-use in the coming two years



Notes:
Value labels for the response categories: 1=not at all, 2=a little, 3=somewhat, 4=a lot
#School participation rate after including replacement schools is below 70%
†International procedures for target-class selection were not followed in all schools
1School participation rate before including replacement schools is below 85%
2School participation rate after including replacement schools is below 85%
3Teacher participation data were collected after survey administration
4Nationally defined population covers less than 90% of the nationally desired population.

W6.8M at http://www.sites2006.net/appendix). However, what is also apparent from this figure is that teachers in Chile, Thailand, and South Africa had by far the highest desire of teachers in the participating systems to use ICT in the following two school years (a mean of about 3.5, with 3=often and 4=nearly always). But why were the teachers in these countries so keen to use ICT? The reason may relate to national policies on education overall and/or to ICT in education policy in particular. Further exploration is needed to determine answers. The corresponding results for mathematics teachers were also similar and are not presented here in the interest of space.

6.6 Summary

This chapter reported on the teachers' personal characteristics and their perception of a range of contextual factors, and how these correlated with their use of ICT in the teaching of their target class.

Teacher age and gender are two demographic characteristics that potentially affect the likelihood of a teacher using ICT in his or her teaching. While we found statistically significant differences between the age and/or gender groups in some systems, no consistent pattern emerged relative to these characteristics. Hence, we can conclude that age and gender effects, where they exist, are results of other age- or gender-related contextual factors rather than simple direct results of the age or gender of the teacher.

In terms of the teachers' qualification, we considered it inappropriate to make cross-system comparisons because the same qualification label can carry different meanings in different systems and sometimes even for the same system at different points in time. Examination of the results within each system showed that, in general, teachers with higher academic qualifications and a teaching license were those teachers most likely to use ICT.

Of all the personal characteristics of the teacher, pedagogical ICT-competence was the best positive predictor of teachers' pedagogical use of ICT. This finding triangulates well with the finding that attending pedagogical ICT-related professional-development associated positively with teachers' use of ICT in teaching. We also found that teachers were generally much more willing to attend pedagogical than technical ICT-related professional development activities. However, we additionally observed wide variations in self-reported technical and pedagogical ICT-competence across systems, as well as a general positive relationship at the system level between a system's mean level of reported ICT-competence and the percentage of teachers within that system who had used ICT with their target class.

Of the three kinds of obstacles to ICT-use, teachers generally found school-related obstacles to be the least serious. In some systems, teachers ranked teacher-related obstacles the most serious obstacles; in others, they gave their highest rankings to student-related obstacles. However, when we conducted a binary logistic regression analysis to explore the extent to which experience of the various obstacles correlated with teachers' pedagogical adoption of ICT, a rather different picture developed. In most systems, it was apparent that both school-related and teacher-related obstacles correlated significantly with lower probabilities of teacher use of ICT. Conversely, in a number of systems, we found that when student-related obstacles were to the fore, teachers were significantly more likely to be using ICT with their target classes. Whether this finding is the result of interaction effects between the different contextual factors, or whether it is the result of some teachers in these systems being more aware of the digital divide and making greater efforts to use ICT in their teaching, is not clear. However, what is clear is that, in general, the extent of student-related obstacles experienced was not a strong predictor of teachers' use of ICT in teaching.

Of the four aspects of a community of practice in schools, the perceived presence was highest for shared vision and lowest for professional collaboration and support. Support, however, was one of the most consistent positive predictors of teachers adopting ICT for their pedagogical activities. Thus, it seems that teachers are more likely to use ICT in their teaching if they feel they and their students are receiving support from the school—support that includes technical and administrative support and that allows students to access ICT outside class hours. Shared decision-making also proved to be a positive predictor of pedagogical ICT-use, followed by professional collaboration.

In most systems, teachers with a stronger traditionally important orientation were less likely to make use of ICT in their teaching while those with a stronger 21st-century orientation were more likely to do so. When asked about their vision for ICT-use in the coming two years, teachers gave priority to 21st-century-oriented practices, a finding that did not tally with the much lower mean percentage of teachers who reported using ICT in corresponding practices with the target class during the surveyed school year. It seems, therefore, that, conceptually, teachers are gaining an increasing awareness of the need to adopt a stronger 21st-century orientation in their ICT-using pedagogical practices. This triangulates well with the stronger 21st-century orientation evident for curriculum goals rather than for teacher and student practices reported in Chapter 5. It also aligns with the finding that in systems where teachers generally showed a higher connectedness orientation, their mean priority for pedagogical ICT-use in the near future was also higher.

Overall, the above findings indicate that teachers' pedagogical orientations correlate with their use of ICT in teaching. Policies to promote ICT-use therefore should include helping teachers develop pedagogical knowledge and skills appropriate for the 21st century.

Chapter Seven

Satisfying Pedagogical Practices Using ICT

International Option

Joke VOOGT

This chapter describes the results of the international option that was included in SITES 2006. The international option, which was part of the teacher questionnaire, solicited responses from teachers on satisfying experiences in their pedagogical use of ICT. Twenty-one of the participating education systems took part in this option, the purpose of which was to follow up on earlier research into innovative pedagogical practices employing substantial use of ICT that was carried out as part of SITES Module 1 and SITES Module 2 (SITES-M1 and SITES-M2).

In this optional component, teachers who used ICT extensively were asked to provide a brief description of the one pedagogical practice involving ICT-use in the target class that they had found the most satisfying. With the description of this practice in mind, teachers were then asked to answer questions reflecting the contribution of ICT to changes in student outcomes and to changes in teaching practices. They were also asked if students or teachers were the main people to initiate several aspects of teaching and learning. The international option aimed to help answer the following research question for SITES 2006: *What ICT was used and how was it used in specific situations where ICT has been used relatively extensively within the pedagogical practice?*

N. Law et al. (eds.), Pedagogy and ICT Use in Schools around the World, 221–250.

7.1 Background to this research component

The international option of SITES 2006 served as a follow-up of SITES-M1 and SITES-M2. In SITES-M1, school principals were asked to describe the most satisfying example of ICT-use in their school. This process allowed collection of additional data needed to shed light on the emerging paradigm, that is, on the way technology facilitates realization of new goals for teaching and learning as emerging from the demands of an information society. The results of this part of SITES-M1 showed that many principals in 1998 were already able to provide examples of satisfying experiences with pedagogical use of computer-related technology. It was striking that, across education systems, a fairly large number of these satisfying experiences showed characteristics consistent with Pelgrum and Anderson's (1999) notion of the *emerging paradigm*.

SITES-M2 was an international study of innovative pedagogical practices that involved use of information and communication technology (ICT). A central focus of SITES-M2 was to find out, through in-depth comparative case studies of innovative exemplars of ICT-using pedagogical practice identified by national panels in the 28 participating systems, the following: the kind of characteristics found in these exemplars; whether there was evidence of paradigmatic changes in pedagogy; and the role played by ICT in such innovations. To submit cases for SITES-M2, the participating education systems had to follow a set of international criteria. These were:

1. The practice shows evidence of significant changes in the roles of teachers and of students, in curriculum goals, in assessment practices, and/or in educational materials
2. Technology plays a significant role in the practice and is a significant contributor to change
3. The practice is sustainable and transferable
4. The practice preferably is associated with positive student outcomes
5. The practice is innovative as locally defined.

For the latter criterion, national panels were appointed to formulate local criteria for innovativeness. (The key findings from this study are summarized in Chapter 1.)

7.2 Design of the international option

Voogt and Pelgrum (2003, 2005) argue that, for many education systems around the world, the implication of change toward the information society is the need for these systems to drastically change their curricula so that students develop competencies not addressed in traditional curricula. According to the European Commission, for instance, all citizens of the European Union should have opportunity to acquire so-called key skills, which include digital literacy and higher-order skills such as teamwork, problem-solving, and project management (European Commission, 2002).

These key skills are often referred to as lifelong-learning competencies. In elaborating on the concept of lifelong learning, education ministers of OECD countries (OECD, 2004) determined that lifelong learning covers all purposeful learning activity in a person's life. A major feature of this concept is developing the capacity of "learning to learn." Essentially, the lifelong-learning approach anticipates the need for societies and individuals to cope with the increased pace of globalization and technological change (OECD, 2004). These changes in society imply that teachers who prepare their students for the information society may aim at a different set of student outcomes than those commonly found in traditional schooling. The analysis of the SITES-M2 innovative practices by Voogt and Pelgrum (2003, 2005) showed that the students involved in the study had developed not only subject-matter knowledge but also information-handling, collaboration, and communication skills.

Developments in the learning sciences (see, for example, Bransford, Brown, & Cocking, 2000) show the benefits of learner-centered forms of instruction. Students are expected to be more actively involved in their own learning process, which asks for different teaching strategies and a change in the responsibilities that students and teachers have traditionally held within the learning process. These findings from research are consistent with the importance policymakers attach to "lifelong learning" and "learning-to-learn" competencies. Voogt (2003) proposed how pedagogical approaches consistent with the expectation and values of the information society might differ from those consistent with the expectations and values of the industrial society. Box 7.1 shows the characteristics of a pedagogical approach we might expect to find in an information society versus a pedagogical approach suited to an industrial society. The words "less/further" and "'more" used in Box 7.1 also indicate that education is today searching for a new balance between what can be termed "traditional" and "'emerging" pedagogies.

As noted above, the SITES-M2 findings emerged from case studies on innovative pedagogical practices using technology. The process of selecting the cases assured the inclusion of innovative pedagogy—as locally defined—but did not provide a representative picture of (innovative) ICT-supported pedagogical practices in schools. This situation was the main reason for exploring the extent to which extensive use of ICT was evident in a representative sample of teachers and schools (as in SITES 2006), and what this implied for ICT-supported pedagogical practices considered important in an information society.

Box 7.1 Overview of pedagogy in an industrial society versus an information society

Aspect	Less or fewer (pedagogy in an industrial society)	More (pedagogy in the information society)
Active	• Activities prescribed by teacher • Whole-class instruction • Variation in terms of activities • Program-determined pace	• Activities determined by learners • Small groups • Variety of activities • Learner-determined pace
Collaborative	• Individual • Homogeneous groups • Likelihood of everyone for him/herself	• Working in teams • Heterogeneous groups • Supporting one another
Creative	• Reproductive learning • Application of known solutions to problems	• Productive learning • Finding new solutions to problems
Integrative	• Linking between theory and practice • Separate subjects • Discipline-based • Individual teachers	• Integrating of theory and practice • Relationships/connections between subjects • Thematic • Teams of teachers
Evaluative	• Teacher-directed • Summative	• Student-directed • Diagnostic
Source: Voogt (2003, p. 222, adapted).		

Based on the above considerations, the SITES research team decided to focus the international option on pedagogical practices being used in the target class and involving extensive use of ICT. For this reason, teachers were asked (question T37) to indicate whether they used ICT "once a week or more in the target class" or whether they used ICT "extensively in the target class during a limited period during the year (e.g., in a project)." Teachers who did not comply with at least one characteristic were not asked to complete the international option; the remaining teachers were those teachers that the research team considered were using ICT extensively in the target class. They were asked to provide a brief description of the one pedagogical practice in which they had used ICT and which they considered the most satisfying. Box 7.2 provides the exact wording (question T38).

Box 7.2 Instruction for the description of most satisfying pedagogical practice

Please describe the one most satisfying pedagogical practice (that you applied in the target class) in this school year, in which you and/or your students used ICT extensively with specific content related to mathematics/science.
Please describe the pedagogical practice (e.g., a research project or a multimedia production), the ICT used (e.g., data-logging tools, spreadsheets or web search), and its content (e.g., curricular goals; topic) in a maximum of 20 words.

With the satisfying pedagogical practice in mind, the teachers were asked to answer three survey questions:

1. Has the use of ICT in this pedagogical practice contributed to changes in the following students' outcomes in the target class? (question T39)
2. Has the use of ICT in this pedagogical practice contributed to changes in the following aspects of your teaching of the target class? (question T40)
3. In this pedagogical practice, who was the main actor [person] in initiating the following aspects of teaching and learning? (question T41)

To design the survey questions the conceptual framework offered in Box 7.1 as well as the checklist (Kozma, 2003), developed and validated for the initial analysis of the SITES-M2 cases, has been used. Twenty-one education systems administered this part of the teacher questionnaire to the teachers participating in SITES 2006. The full questionnaire can be found in the online appendix (http://www.sites2006.net/appendix).

The results presented below are based on an analysis of the data collected from teachers who used ICT extensively and who responded with "yes" to the question "Do you use ICT in the teaching and learning activities of the target class?"

7.3 Some illustrative examples

Teachers used their native language when describing their satisfying pedagogical practice. A quick inspection of the descriptions of practices from teachers in English-speaking nations revealed that there were many differences with respect to information richness in the description provided. Some descriptions were brief and mentioned only the ICT applications used; other descriptions included more detail about content and pedagogy. Also, some of the longer descriptions were incomplete because of the limited space available in the online data collection. For this reason, analyzing all descriptions was not seen as a useful task. Instead, a decision was made to use a selection of the more informative descriptions as illustrative examples for this chapter.

Five mathematics and five science examples that were both long and complete were selected from the database of each participating system. The national research coordinators (NRCs) were then asked to translate these descriptions into English. Translations were received from all education systems, except Chinese Taipei. One mathematics example and one science example were then selected from each set of 10 examples per education system in order to illustrate the kinds of practices that teachers had in mind when responding to the survey questions of the international option. In most cases, the item chosen was the first long and informative example from the database. Box 7.3 (mathematics) and Box 7.4 (science) present examples of satisfying practices from the countries that participated in the international option.

Although it was not possible to analyze the examples the teachers provided, the general impression that emerged was consistent with the findings of SITES-M1 and SITES-M2, namely that students were engaging in information-processing, production activities, and communication, for which they were mostly using general-purpose software, the internet, and, on occasion, specific educational software. This broad use of general-purpose software and the internet in education is also consistent with findings from other studies (e.g., Becker, Rawitz, & Wong, 1999; van Kessel, Hulsen, & van der Neut, 2005). The examples provided also demonstrate that the teachers were using ICT creatively in their educational practice. According to Voogt (in press), the examples of satisfying ICT-use provided by teachers and principals in international studies like SITES-M1 and SITES-M2 show only limited use of all the possibilities IT offers, although use is being made of the basic possibilities—information retrieval and communication. The examples generated in SITES 2006 offer the same impression.

Box 7.3 Examples of most-satisfying pedagogical practices in mathematics from countries participating in the international option

Using Geometer's Sketchpad when teaching π (ratios of perimeter to diagonal in polygons and how π is the limit). Also Geometer's Sketchpad is extremely useful for angles and other geometry concepts. *Mathematics, Ontario, Canada*
Students had to do a price comparison of different floor coverings for their bedroom. They were to provide a scale drawing , a spreadsheet comparison and a graph comparison of cost. *Mathematics, Alberta,Canada*
Using a CDROM to work on Pythagorean Theorem in a game with students of Grade 8 who have great learning difficulties. *Mathematics, France*
Learning exponentiation formulas with the help of a computer program was nice especially with the less advanced students. It is important that there are tasks requiring different levels of knowledge and that there is access to the computer during the classes. *Mathematics, Finland*
Statistical work with spreadsheets, where we exchange data with another school in town via skolekom (the national school network). We make tables and diagrams for use when describing the town's traffic centers. *Mathematics, Denmark*
I have used the educational package "Live Math". ICT was also used for intermediate evaluation (tests), analysis of results and computer exercises. The level of training as well as the quality of student's knowledge has increased as a result. *Mathematics, Russian Federation*
Multimedia production in geometry. Identification and characteristics of angles, triangles and boxing rings ... exploring relations between parallel bars, rotation, symmetry, perimeters, areas and volumes. *Mathematics, Chile*
Exploration of Polygons. This is a cross-curriculum project with ICT. Students are expected to use PowerPoint to present information they find about properties, formulas, constructions, and applications of polygons *Mathematics, Hong Kong SAR*
Teaching the relative position of two circles or the relative position of a circle and a line by means of the "Cabri geometry" program. This program is easy to use and provides high visualization for better understanding and mastering a topic. *Mathematics, Slovak Republic*
In a project about the Pythagorean Theorem the students were required to enter websites that deal with Pythagoras and read and summarize them. They had to answer questions related to the theorem. In these websites, in fact, they learned independently what the Pythagorean Theorem is. *Mathematics, Israel*

Box 7.4 Examples of most-satisfying pedagogical practices in science from countries participating in the international option

Using ICT in teaching and learning about the digestive system. Students had to study diseases in the digestive system. They searched a variety of resources and did a survey among people in the community. They presented their findings via a website and produced a leaflet using PowerPoint. *Science, Thailand*
"Look into the past from the school laboratory" was an integrated project that combined history, chemistry and literature. Students used digital video cameras as well as the Internet to collect data. As a result the motivation (interest) to study these subjects has increased. *Science, Moscow, Russian Federation*
With the use of "Crocodile" software it is possible to demonstrate chemical reactions using various substances which are not used during lessons or which are not available. We aim at solidifying the pupils' knowledge about chemical ware and tools, metals and non-metals, changes in chemical reactions, etc. *Science, Lithuania*
A research project on climate change was carried out as a synthesis of the themes concerning atmosphere, hydrosphere, and the planet Earth. Students were organized in cooperative working groups to search and use internet data. Word-processing and multimedia materials have been used. *Science, Catalonia, Spain*
Sex education project in Science. Students searched for information on the internet about the consequences of sexual intercourse [and] made graphs with Excel about the probability of getting venereal deseases in genetics. *Science, Italy*
The learners were asked to do research from the library or an internet café about the population of the country. The response was overwhelming. Learners did the research although some did not have money to use the internet café. *Science, South Africa*
We participated in an environmental project "Baltic week," which linked 7 countries around the Baltic Sea. We used spreadsheets to gather and process data. *Science, Estonia*
Project work in Science on diseases. The pupils used the internet to gather information, used PowerPoint for presentations, and word-processing and digital photos for their written presentations. *Science, Norway*
Simulation software was used to show the diurnal motion of the sun and the stars on the screen in the class. It was more effective than showing still images. *Science, Japan*
Students prepared a project on a chosen topic (e.g., weather, air, a well-known physicist), they used the Internet to search for information and a text editor for writting the project. *Science, Slovenia*

7.4 Extent of use

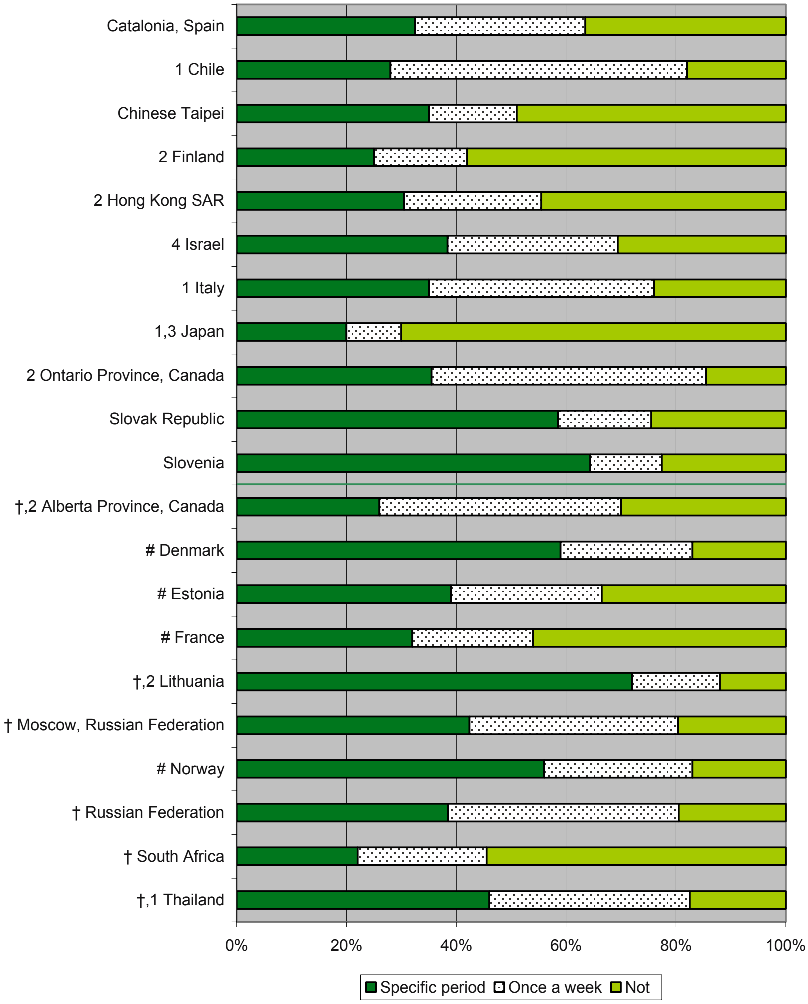
Figures 7.1a and 7.1b present the results per country of the percentage of mathematics teachers and the percentage of science teachers who were using ICT extensively. In six education systems (Catalonia, Chinese Taipei, France, Finland, Japan, and South Africa), one third or more of the science teachers were not using ICT in such an extensive manner. For mathematics teachers, this degree of use was the case in eight education systems (Catalonia, Chinese Taipei, Estonia, Finland, France, Hong Kong, Japan and South Africa). The use of ICT during a specific period (in a theme or a project) in the school year was common in most participating systems. Exceptions were Alberta, Chile, Hong Kong (for science only), Italy, Ontario, and the Russian Federation (for mathematics only). In these systems, the teachers were commonly using ICT on a weekly basis.

7.5 Changes in student outcomes

The participating teachers were asked whether the use of ICT in the pedagogical practice they had in mind contributed to changes in students' outcomes. Figures 7.2a and 7.2b present the results. It is worth mentioning that, according to the teachers, changes in student outcomes due to the use of ICT in the pedagogical practice were mostly seen to either increased or did not change.

Figures 7.2a and 7.2b show that more than half of both sets of teachers of the target grade reported an increase in student outcomes on all but one item for their specified pedagogical practice. In particular, students' learning motivation, ICT-skills, information-handling skills, and subject-matter knowledge increased according to more than 70% of both teacher populations. Although the examples provided by the teachers within the education systems often did not explicitly mention how ICT in the practice contributed to student outcomes, implicitly the examples show that ICT was contributing to students' learning motivation, students' ICT-skills, students' information-handling skills, and students' understanding of subject matter. It should be noted, however, that the achievement gap between students increased according to about 35% of the mathematics and the science teachers, and decreased according to 7% of the teachers. A closer analysis of the data is presented in Table 7.1. The table compares teachers who used ICT on a weekly basis with teachers who used ICT

Figure 7.1a Extent and modes of extensive use of ICT by mathematics teachers



Notes:

[#]School participation rate after including replacement schools is below 70%

[†]International procedures for target-class selection were not followed in all schools

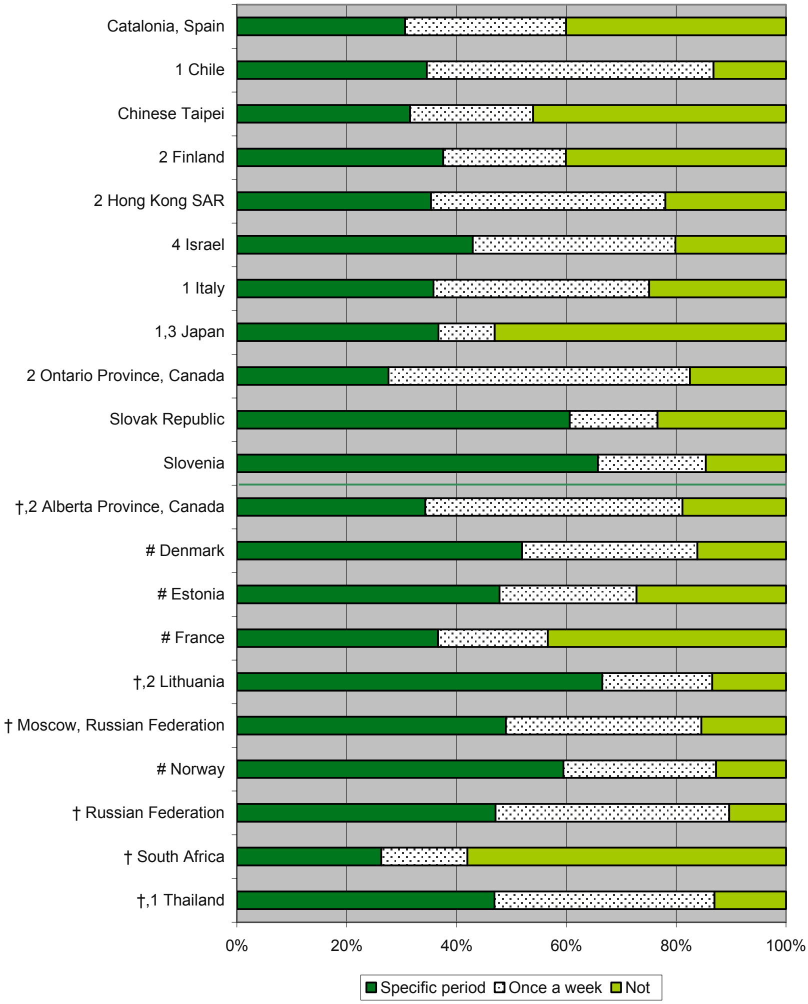
[1]School participation rate before including replacement schools is below 85%

[2]School participation rate after including replacement schools is below 85%

[3]Teacher participation data were collected after survey administration

[4]Nationally defined population covers less than 90% of the nationally desired population.

Figure 7.1b Extent and modes of extensive use of ICT by science teachers



Notes:

[#]School participation rate after including replacement schools is below 70%

[†]International procedures for target-class selection were not followed in all schools

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[2]School participation rate after including replacement schools is below 85%

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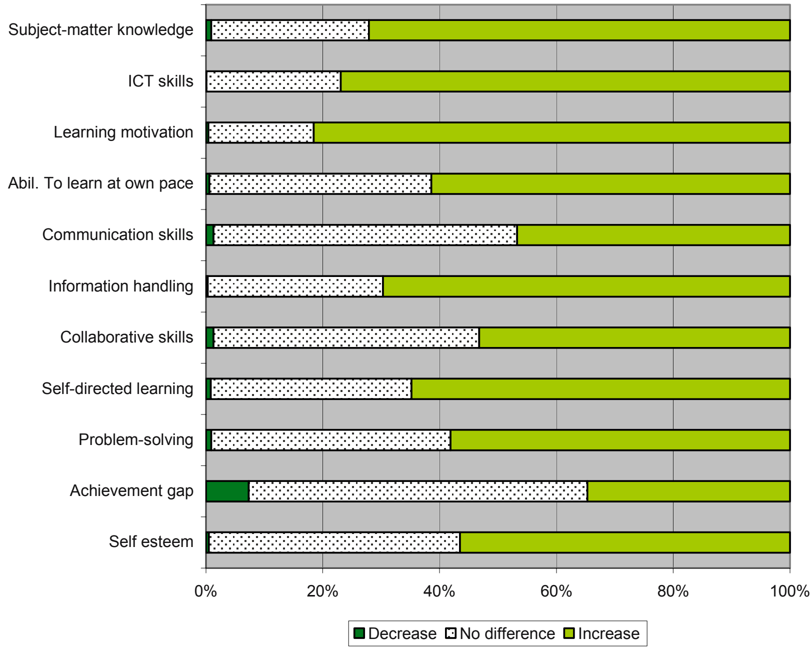
Figure 7.2a Mathematics teachers' perceptions of changes in student outcomes due to ICT



Notes:
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†International procedures for target-class selection were not followed in all schools
[1]School participation rate before including replacement schools is below 85%
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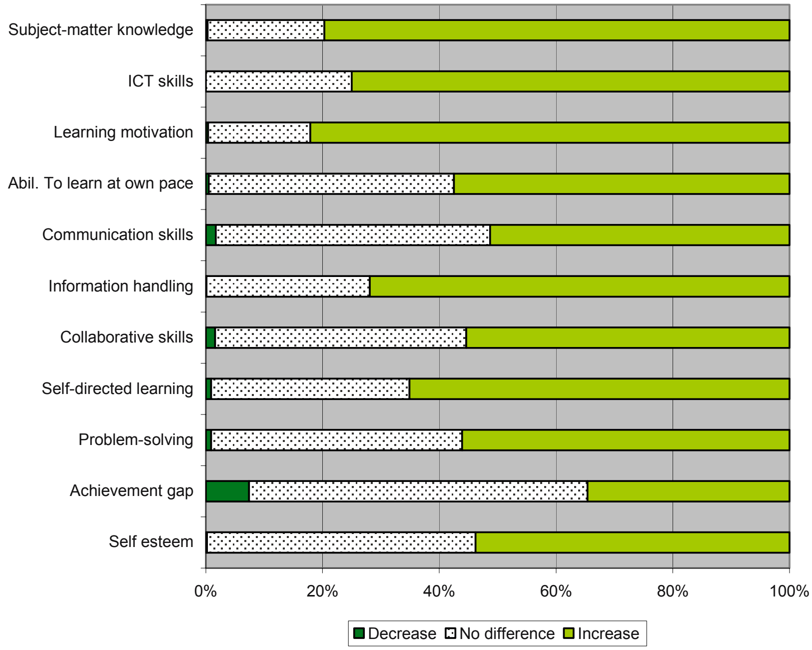
extensively during a specific period in the school year in Grade 8. More specifically, the results present the percentage of teachers who reported that the various student outcomes increased due to the use of ICT in the pedagogical practice. Compared to those teachers who used ICT during a specific period in the school year, the science teachers and the mathematics teachers who used ICT on a weekly basis appear to have been more convinced that students' ICT-skills, learning motivation, ability to learn at their own pace, communication skills, problem-solving skills, and self-esteem increased. In addition, the science teachers who used ICT on a weekly basis were more likely than their science colleagues who used ICT during a specific period of the school year to report an increase in information-handling skills. Mathematics teachers and science teachers

Figure 7.2b Science teachers' perceptions of changes in student outcomes due to ICT



Notes:
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who used ICT once a week were also more likely than their colleagues who used ICT during a specific period during the school year to report an increase in the achievement gap.

Table 7.2 compares the percentages of mathematics teachers who reported an increase in various kinds of student outcomes as a result of the particular example of satisfying pedagogical practice. Mathematics teachers in Japan (40%), Finland (50%), France (49%), Hong Kong (49%), South Africa (50%), and Norway (50%) reported a relatively low increase in student outcomes. Conversely, teachers from Thailand (89%), Chile (82%), Israel (74%), Italy (74%), and Moscow (74%) reported a high increase in student outcomes. Similar results were obtained from science teachers. Science teachers from Finland (49%), Hong Kong (47%), Japan

Table 7.1 Increase in aspects of student outcomes; comparison of perceptions of mathematics teachers and science teachers who were using ICT on a weekly basis and those who were using ICT during a specific period in the school year (% and (s.e.))

Education system	Mathematics teachers		Science teachers	
	Use once a week	Use specific period in school year	Use once a week	Use specific period in school year
Subject-matter knowledge	75 (2.1)	72 (1.6)	81 (1.5)	79 (1.2)
ICT-skills	80 (1.8)	76 (1.6)	77 (1.5)	73 (1.3)
Learning motivation	85 (1.7)	81 (1.7)	84 (1.3)	81 (1.2)
Ability learn own pace	64 (2.3)	59 (1.7)	59 (1.8)	57 (1.5)
Communication skills	52 (2.4)	44 (1.7)	55 (1.8)	48 (1.5)
Information-handling	71 (2.3)	69 (1.7)	75 (1.6)	70 (1.3)
Collaborative skills	55 (2.2)	53 (1.7)	57 (1.7)	55 (1.4)
Self-directed learning	64 (2.3)	66 (1.7)	66 (1.7)	64 (1.4)
Problem-solving	62 (2.4)	57 (1.7)	60 (1.8)	53 (1.4)
Achievement gap	39 (2.1)	32 (1.8)	37 (1.7)	33 (1.4)
Self-esteem	59 (2.3)	54 (1.5)	57 (1.6)	51 (1.3)

(41%), and Norway (51%) reported a relatively low increase, while science teachers from Chile (81%), Moscow (76%), and Thailand (88%) reported a relatively high increase. The corresponding percentages of science teachers who perceived increases in student outcomes can be found in the online appendix (http://www.sites2006.net/appendix).

7.6 Changes in teaching practices

Teachers were asked whether the use of ICT in the pedagogical practice they had specified had contributed to changes in their teaching practices in the target class; the results are presented in Figures 7.3a and 7.3b. A large majority of the mathematics and the science teachers reported that ICT in the pedagogical practice had led to an increase in variety of the learning resources (mathematics, 84%; science, 88%) and the learning activities (mathematics, 83%; science, 85%) they used. They also reported an increase in available content (mathematics, 71%; science 82%). In addition, more than half of the mathematics teachers and the science teachers observed that they were better able to adapt to the individual needs of their students (mathematics, 62%; science, 59%), and mentioned an increase in the quality of instruction (mathematics, 60%; science, 64%) and coaching (mathematics, 54%; science, 54%). Both populations of teachers also mentioned increased collaboration between students (mathematics, 54%; science, 55%), and reported an increase in self-confidence (mathematics, 56%; science, 53%). However, both the science teachers and the mathematics teachers reported that the time they needed for preparation had increased (mathematics, 59%; science, 56%).

It is noteworthy that about half of the mathematics teachers and of the science teachers did not see any difference in terms of their use or non-use of ICT in the time they needed to coach individual students, the time they needed to solve technical problems, and the time they needed for classroom management. Also, about half of both sets of teachers did not perceive a difference in regard to their normal routines and in the insight they had into their students' learning progress. In addition, about half of the teachers saw no difference in the quality of classroom discussion. While about one sixth of the mathematics teachers and the science teachers (15% and 16% respectively) reported that the amount of effort needed to motivate students had decreased relative to their usual teaching practice, about half mentioned an increase in the amount of effort needed to motivate students. This result may indicate that many teachers were making considerable effort to prepare practices that would motivate their students.

Table 7.3, which compares the teachers who were using ICT on a weekly basis with the teachers who were using ICT during a specific period during the school year, shows whether the various teaching practices increased as a result of ICT-use. Relatively large differences between the two groups in favor of those teachers using ICT on a weekly basis can be noticed with regard to quality of coaching, quality of instruction, insight into student progress, and time available for individual students. Moreover, science teachers using ICT on a weekly basis reported, more so than their science colleagues using ICT over a specific period during the school year, increases in communication with the world outside the school, the quality of classroom discussion, new learning content, possibility to adapt to students' individual needs, efforts to motivate students, and self-confidence. The science teachers who were using ICT on a weekly basis also noticed, unlike their colleagues using ICT less frequently, an increase in time needed to solve technical problems. Considerably more science teachers using ICT on a weekly basis than

Table 7.2 Mathematics teachers who perceived increases in student outcomes (% and (s.e.))

Education system	Subject-matter knowledge	ICT skills	Learning motivation	Abil. learn own pace	Communication skills	Information-handling	Collaborative skills	Self-directed learning	Problem-solving	Achievement gap	Self esteem
Catalonia, Spain	74 (3.5)	86 (3.1)	83 (3.6)	70 (4.3)	35 (4.5)	71 (4.0)	54 (3.8)	59 (4.0)	50 (4.4)	35 (4.2)	64 (3.9)
[1] Chile	90 (1.9)	90 (2.0)	94 (1.5)	83 (2.7)	74 (3.0)	91 (2.0)	79 (2.9)	80 (3.0)	79 (2.5)	51 (3.4)	89 (2.1)
Chinese Taipei	79 (3.5)	76 (3.7)	88 (2.5)	59 (4.2)	42 (4.1)	73 (4.2)	60 (4.4)	75 (3.7)	70 (3.8)	52 (3.6)	49 (4.3)
[2] Finland	50 (5.1)	63 (5.4)	72 (4.9)	61 (5.0)	39 (5.2)	61 (5.1)	32 (5.0)	62 (4.9)	46 (4.9)	13 (3.3)	47 (5.2)
[2] Hong Kong, SAR	76 (3.2)	51 (3.4)	80 (2.4)	43 (3.3)	35 (3.5)	54 (3.2)	34 (3.6)	48 (3.6)	57 (3.1)	29 (3.0)	32 (3.0)
[4] Israel	89 (3.0)	80 (4.1)	84 (3.8)	80 (3.7)	72 (4.2)	81 (4.0)	73 (4.2)	82 (3.7)	73 (5.0)	31 (4.0)	64 (4.7)
[1] Italy	83 (2.3)	91 (1.7)	90 (2.1)	68 (3.1)	58 (3.0)	78 (2.4)	77 (2.6)	65 (3.1)	62 (3.1)	52 (3.6)	85 (2.3)
[1, 3] Japan	55 (8.7)	53 (8.2)	65 (8.3)	43 (7.2)	23 (7.6)	37 (8.2)	20 (6.6)	55 (8.2)	43 (7.3)	35 (8.1)	14 (6.1)
[2] Ontario Province, Canada	73 (3.0)	87 (2.1)	77 (2.7)	62 (3.0)	50 (3.2)	69 (3.1)	43 (3.3)	61 (3.4)	58 (3.5)	28 (3.0)	57 (3.5)
Slovak Republic	62 (3.5)	87 (2.7)	70 (3.7)	46 (3.6)	46 (3.5)	80 (3.1)	57 (3.5)	56 (3.7)	55 (3.6)	17 (2.9)	62 (3.6)
Slovenia	60 (3.5)	84 (2.8)	91 (2.2)	61 (3.4)	40 (3.3)	74 (3.0)	55 (3.4)	69 (3.8)	49 (3.8)	38 (3.6)	55 (3.4)
[†, 2] Alberta Province, Canada	71 (4.0)	79 (3.2)	69 (4.6)	51 (4.4)	47 (4.3)	65 (3.8)	43 (4.4)	60 (4.2)	54 (4.6)	28 (3.6)	46 (4.3)
[#] Denmark	70 (3.5)	83 (2.8)	76 (3.1)	60 (3.5)	43 (3.6)	60 (3.7)	24 (3.1)	41 (3.3)	43 (3.9)	36 (3.6)	50 (3.6)
[#] Estonia	75 (5.6)	74 (5.8)	74 (5.5)	55 (6.6)	36 (6.4)	66 (6.4)	61 (6.6)	69 (5.8)	51 (6.5)	45 (6.3)	51 (6.7)
[#] France	51 (5.6)	70 (5.1)	80 (3.6)	52 (6.1)	30 (4.9)	46 (4.9)	44 (4.9)	42 (5.9)	38 (6.1)	28 (5.1)	58 (5.9)
[†, 2] Lithuania	69 (3.7)	96 (1.2)	77 (3.0)	63 (3.9)	66 (3.6)	88 (2.4)	75 (2.8)	75 (3.2)	60 (3.7)	43 (3.5)	50 (4.0)
[†] Moscow, Russian Federation	83 (2.8)	78 (2.8)	89 (2.5)	68 (3.6)	65 (3.5)	92 (2.0)	70 (3.5)	88 (2.3)	72 (3.6)	46 (3.8)	67 (3.4)
[#] Norway	52 (3.6)	96 (1.4)	80 (2.7)	30 (3.4)	48 (3.7)	71 (3.0)	24 (3.6)	38 (4.0)	32 (3.4)	32 (3.0)	42 (4.0)
[†] Russian Federation	72 (5.1)	74 (4.8)	80 (2.6)	62 (5.2)	57 (4.3)	87 (2.6)	65 (4.5)	80 (3.3)	64 (5.0)	50 (3.7)	58 (4.7)
[†] South Africa	56 (8.4)	46 (7.4)	55 (8.0)	53 (8.0)	62 (8.2)	51 (8.7)	37 (8.7)	38 (8.2)	61 (8.7)	40 (9.2)	56 (8.4)
[†, 1] Thailand	81 (2.9)	95 (1.8)	98 (1.0)	94 (1.6)	84 (3.1)	90 (2.4)	83 (3.2)	97 (1.0)	88 (2.5)	81 (3.3)	83 (3.3)

Notes: Value labels for the response categories: 1=never, 2=sometimes, 3=often, 4=nearly always

[#] School participation rate after including replacement schools is below 70%

[†] International procedures for target-class selection were not followed in all schools

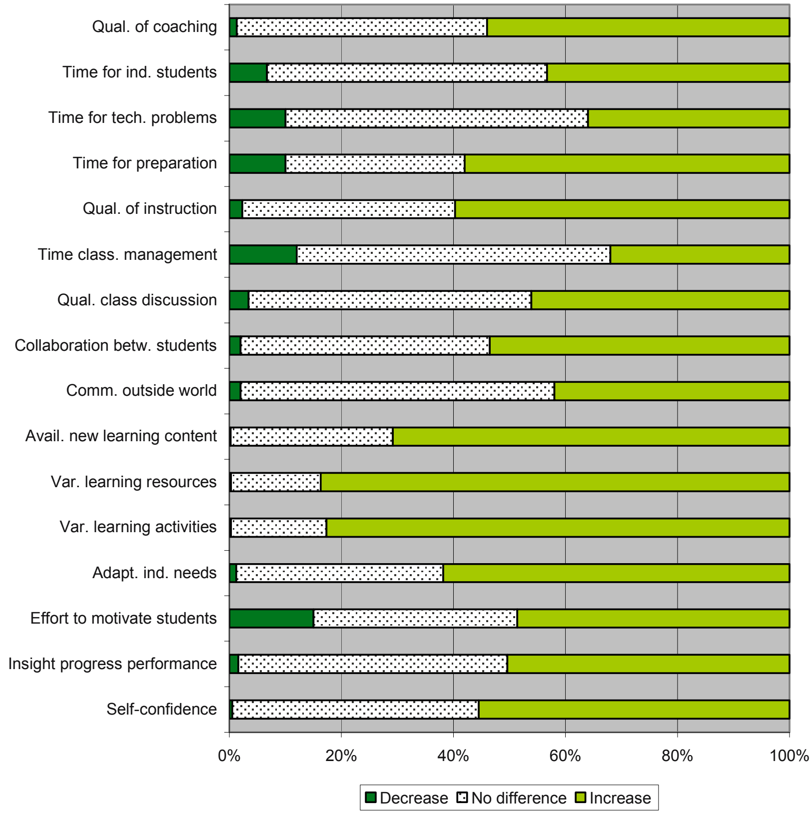
[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Teacher participation data were collected after survey administration

[4] Nationally defined population covers less than 90% of the nationally desired population.

Figure 7.3a Mathematics teachers' perceptions of changes in teaching practices due to ICT use in the specified pedagogical activity



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science colleagues using ICT during a specific period of the school year reported an increase in the variety of learning activities. For mathematics teachers, the trend seemed to be the reverse: more of the mathematics teachers using ICT during a specific period of the school year than colleagues using ICT weekly reported an increase in the variety of learning activities.

Table 7.4 presents, per country, how the teachers perceived ICT (as used in their specified pedagogical practices) had changed their teaching practices. Compared to their colleagues in the other education systems, relatively few teachers from Denmark, Finland, Japan, and Norway reported an increased use of various aspects of their teaching practice. Contrary to this, relatively large numbers of teachers from Chile, Moscow, and Thailand reported an increase in various aspects of their teaching practice as a result of ICT-use. Similar results were evident for science teachers, with relatively few from Denmark, Finland, Japan, and Norway reporting increased use, and a good number from Chile and Thailand

Figure 7.3b Science teachers' perceptions of changes in teaching practices due to ICT use in the specified pedagogical activity

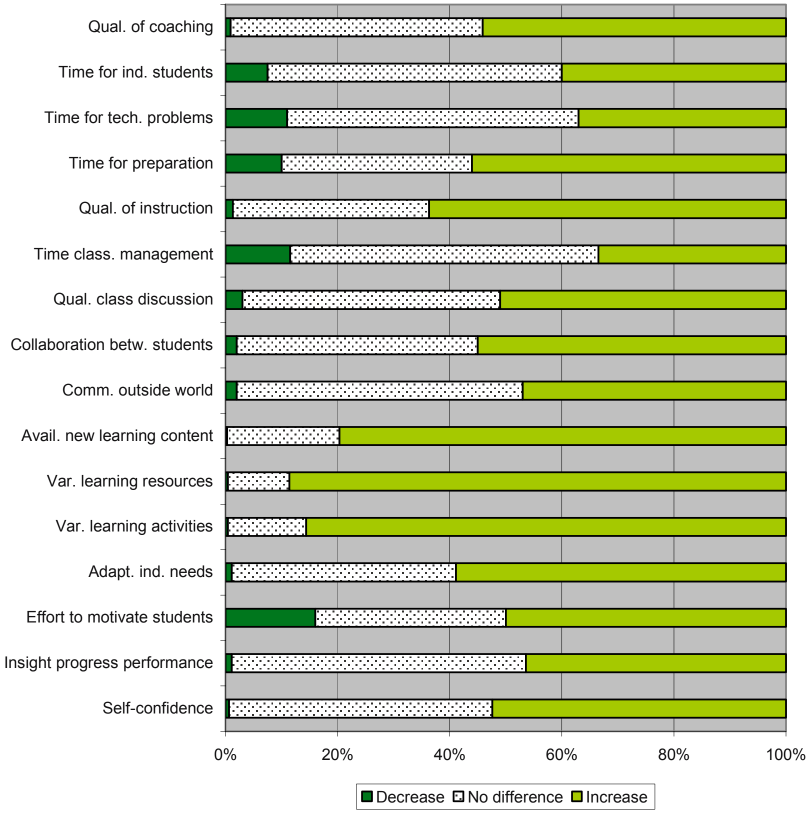

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Table 7.3 Increase in aspects of teaching; comparison of perceptions of mathematics and science teachers who were using ICT on a weekly basis and those teachers using ICT during a specific period of the school year (% and (s.e.))

Change in teaching practice	Mathematics teachers		Science teachers	
	Use once a week	Use specific period in school year	Use once a week	Use specific period in school year
Qual. of coaching	59 (2.3)	51 (1.7)	61 (1.7)	51 (1.4)
Time for ind. students	47 (2.3)	41 (1.9)	45 (1.9)	36 (1.5)
Time for tech. problems	38 (2.3)	35 (1.7)	43 (1.8)	34 (1.5)
Time for preparation	58 (2.4)	59 (1.7)	57 (1.8)	56 (1.5)
Qual. of instruction	63 (2.2)	58 (1.8)	70 (1.8)	61 (1.4)
Time class. management	34 (2.2)	31 (1.6)	35 (1.6)	32 (1.4)
Qual. class discussion	48 (2.3)	46 (1.7)	56 (1.7)	48 (1.3)
Collaboration betw. students	55 (2.4)	53 (1.5)	55 (1.5)	55 (1.4)
Comm. outside world	43 (2.2)	43 (1.7)	50 (1.5)	45 (1.4)
Avail. new learning content	75 (2.2)	71 (1.6)	83 (1.2)	78 (1.2)
Var. learning resources	83 (2.0)	85 (1.4)	90 (0.9)	88 (1.0)
Var. learning activities	81 (2.1)	86 (1.3)	88 (1.2)	84 (1.1)
Adapt. ind. needs	63 (2.4)	61 (1.8)	61 (1.7)	57 (1.5)
Effort to motivate students	49 (2.3)	48 (1.6)	52 (1.7)	48 (1.4)
Insight progress performance	53 (2.3)	47 (2.0)	51 (1.8)	43 (1.4)
Self-confidence	57 (2.4)	54 (1.7)	57 (1.8)	51 (1.4)

reporting increased use. The online appendix provides detailed information for each country regarding science teachers' perceptions of changes in teaching practice (http://www.sites2006.net/appendix).

7.7 Person initiating teaching and learning aspects

The participating teachers were asked to identify who was the main initiator of aspects of teaching and learning in the pedagogical practice that they each had in mind. The results in Figures 7.4a and 7.4b clearly show that, for all aspects of teaching and learning, most of the Grade 8 mathematics teachers and the Grade 8 science teachers reported themselves as the main initiators of teaching and learning in the pedagogical practice they had each specified.

However, a relatively large number of teachers—albeit somewhat under half of each population—said that their Grade 8 students initiated the organization of group work (43% of mathematics teachers and 45% of science teachers) and took the initiative to demonstrate their achievement (42% of mathematics teachers and 42% of science teachers). For all other aspects of teaching and learning, less than 30% of both sets of teachers reported that their students took the initiative.

Table 7.5 compares teachers who were using ICT on a weekly basis with colleagues who were using ICT in a specific period of the school year in terms of which person they thought took the initiative in relation to various aspects of teaching and learning. The table presents the percentage of teachers who reported students as the initiators. Although it is evident from the table that the differences between the two groups were small, the results nonetheless suggest that those mathematics teachers and science teachers who were more inclined to use ICT extensively during a specific period in the school year were the group most likely to report that students took the initiative in organizing group work. In addition, this same set of teachers was more likely than the other group to report that their students took the initiative to demonstrate their achievement.

Table 7.6 presents the results of the "initiator" comparison between mathematics teachers who were weekly users of ICT and those who were specific-period-of time users. (Corresponding information for the science teachers is reported in the online appendix http://www.sites2006.net/appendix). The table shows, per system, the percentage of teachers who reported that students were the initiators. As with the earlier comparisons in this chapter, the results again provide a varied picture.

A closer look at these data was made possible by grouping the different aspects of teaching and learning into four broad curriculum categories: content and goals of learning; organization of time and location; organization of the learning process; and assessment. Figures 7.5

Table 7.4 Mathematics teachers' perceptions of changes (increase) in teaching practices (% and (s.e.))

	Education system	Qual. of coaching	Time for ind. students	Time for tech. problems	Time for prepa-ration	Qual. of instruction	Time class. manage-ment	Qual. class discussion	Collabora-tion betw. students	Comm. outside world	Avail. new learning content	Var. learning resources	Var. learning activities	Adapt. ind. needs	Effort to motivate students	Insight progress perfor-mance	Self-confidence
	Catalonia, Spain	57 (4.3)	40 (4.7)	34 (4.4)	59 (4.5)	44 (4.2)	33 (4.2)	40 (4.2)	55 (4.4)	45 (4.6)	65 (3.8)	88 (2.8)	88 (2.5)	65 (4.3)	27 (3.6)	43 (5.0)	58 (4.7)
1	Chile	81 (2.9)	60 (3.0)	37 (3.9)	45 (3.3)	73 (3.2)	49 (3.8)	68 (3.6)	82 (2.8)	62 (3.7)	90 (1.9)	93 (1.6)	93 (1.7)	76 (3.0)	59 (3.9)	75 (3.2)	84 (2.6)
	Chinese Taipei	48 (4.3)	39 (4.1)	50 (4.2)	78 (3.9)	67 (4.3)	34 (4.1)	59 (4.0)	57 (4.2)	40 (4.3)	84 (3.4)	89 (2.6)	86 (3.0)	62 (4.7)	80 (3.4)	57 (4.2)	64 (4.0)
2	Finland	34 (5.5)	39 (5.2)	30 (4.9)	55 (5.6)	34 (5.2)	17 (4.4)	30 (4.5)	23 (4.2)	22 (4.4)	60 (5.6)	75 (5.1)	80 (4.5)	48 (5.8)	23 (4.4)	32 (4.7)	41 (5.2)
2	Hong Kong SAR	25 (3.2)	27 (2.6)	41 (3.5)	73 (3.3)	73 (2.7)	43 (3.5)	52 (3.4)	37 (3.4)	28 (3.1)	60 (3.5)	77 (2.9)	78 (2.8)	43 (3.1)	62 (3.4)	48 (3.7)	38 (3.3)
4	Israel	78 (4.7)	54 (5.3)	45 (5.0)	69 (5.1)	81 (3.9)	42 (5.0)	65 (4.2)	69 (4.5)	64 (5.0)	76 (4.2)	81 (4.3)	85 (3.4)	80 (3.7)	55 (4.5)	64 (5.3)	63 (4.4)
1	Italy	79 (2.5)	44 (3.3)	36 (3.2)	45 (3.2)	86 (1.8)	34 (2.9)	52 (3.6)	79 (2.3)	60 (2.8)	91 (1.7)	93 (1.4)	91 (1.7)	70 (2.9)	72 (2.9)	67 (3.1)	70 (3.2)
1, 3	Japan	28 (6.8)	49 (9.1)	26 (7.1)	66 (7.5)	26 (7.4)	08 (4.8)	09 (4.8)	17 (7.3)	20 (6.9)	48 (7.5)	71 (7.8)	63 (8.1)	51 (8.5)	37 (6.9)	37 (8.5)	29 (7.4)
2	Ontario Province, Canada	40 (3.0)	32 (3.1)	41 (3.5)	52 (3.2)	62 (3.6)	14 (2.4)	37 (3.1)	52 (3.3)	40 (3.4)	80 (2.7)	86 (2.4)	82 (2.2)	59 (3.2)	22 (2.9)	44 (3.4)	50 (3.7)
	Slovak Republic	49 (3.7)	44 (4.3)	37 (3.9)	62 (3.9)	58 (4.1)	49 (3.8)	55 (3.2)	64 (3.7)	55 (3.2)	72 (3.4)	85 (3.0)	84 (3.2)	61 (3.8)	42 (3.6)	45 (3.5)	62 (3.5)
	Slovenia	76 (3.1)	47 (4.0)	22 (3.0)	41 (3.7)	57 (3.7)	34 (3.6)	39 (3.4)	54 (3.4)	30 (3.0)	57 (3.7)	87 (2.5)	83 (2.5)	65 (3.3)	53 (3.4)	40 (3.9)	52 (3.6)
†, 2	Alberta Province, Canada	44 (4.4)	39 (4.4)	40 (4.4)	54 (4.1)	62 (4.1)	20 (4.0)	37 (4.1)	41 (4.4)	42 (4.3)	70 (3.9)	85 (2.9)	89 (2.5)	58 (4.0)	29 (4.3)	44 (4.3)	46 (3.9)
#	Denmark	26 (2.9)	23 (3.0)	42 (4.0)	47 (3.5)	32 (3.4)	15 (2.6)	23 (3.2)	32 (3.7)	30 (3.0)	77 (2.8)	53 (3.4)	57 (3.1)	53 (3.5)	20 (2.7)	30 (3.2)	39 (3.4)
#	Estonia	64 (6.4)	39 (6.7)	51 (6.3)	80 (5.3)	60 (6.4)	26 (5.7)	39 (6.4)	63 (6.1)	50 (6.3)	86 (4.8)	85 (4.8)	88 (4.5)	59 (7.2)	43 (6.7)	57 (6.8)	62 (7.1)
#	France	57 (5.1)	46 (5.5)	45 (5.4)	70 (5.0)	44 (5.6)	33 (4.4)	44 (4.3)	48 (5.8)	15 (3.9)	67 (4.9)	84 (3.3)	88 (2.7)	54 (5.8)	29 (4.5)	36 (5.5)	52 (5.3)
†, 2	Lithuania	70 (3.4)	47 (4.0)	48 (3.9)	75 (3.9)	85 (2.8)	68 (3.1)	49 (4.1)	74 (3.0)	78 (3.1)	86 (2.7)	98 (1.0)	87 (2.4)	58 (3.3)	75 (3.4)	41 (3.8)	70 (3.5)
†	Moscow, Russian Federation	84 (2.6)	58 (3.1)	42 (3.7)	53 (4.1)	60 (3.9)	33 (3.5)	64 (3.7)	74 (3.2)	76 (3.1)	89 (2.3)	94 (1.8)	93 (1.7)	78 (3.0)	11 (2.4)	57 (3.7)	74 (2.9)
#	Norway	26 (3.8)	24 (3.1)	26 (3.3)	39 (3.9)	59 (3.9)	35 (3.9)	14 (2.9)	29 (3.8)	30 (3.7)	73 (3.6)	73 (3.5)	84 (2.6)	55 (3.9)	33 (3.3)	25 (3.6)	34 (4.0)
†	Russian Federation	76 (3.6)	55 (4.5)	38 (4.3)	59 (4.1)	61 (5.3)	20 (4.3)	56 (5.2)	61 (4.2)	72 (3.5)	83 (3.3)	82 (2.6)	89 (2.1)	66 (4.8)	13 (4.2)	53 (4.4)	78 (3.9)
†	South Africa	62 (8.8)	47 (8.7)	41 (9.0)	50 (8.6)	62 (8.9)	49 (8.6)	56 (8.3)	49 (9.0)	38 (8.7)	55 (8.9)	42 (8.8)	49 (9.1)	45 (8.9)	49 (8.5)	51 (8.6)	61 (8.9)
†, 1	Thailand	88 (2.4)	63 (4.1)	60 (4.4)	60 (4.2)	93 (2.2)	52 (4.5)	75 (3.9)	91 (2.2)	86 (2.9)	94 (2.0)	95 (1.5)	96 (1.3)	87 (2.7)	76 (3.3)	86 (2.9)	91 (2.1)

Notes: Value labels for the response categories: 1=never, 2=sometimes, 3=often, 4=nearly always

[#] School participation rate after including replacement schools is below 70%

[†] International procedures for target-class selection was not followed in all schools

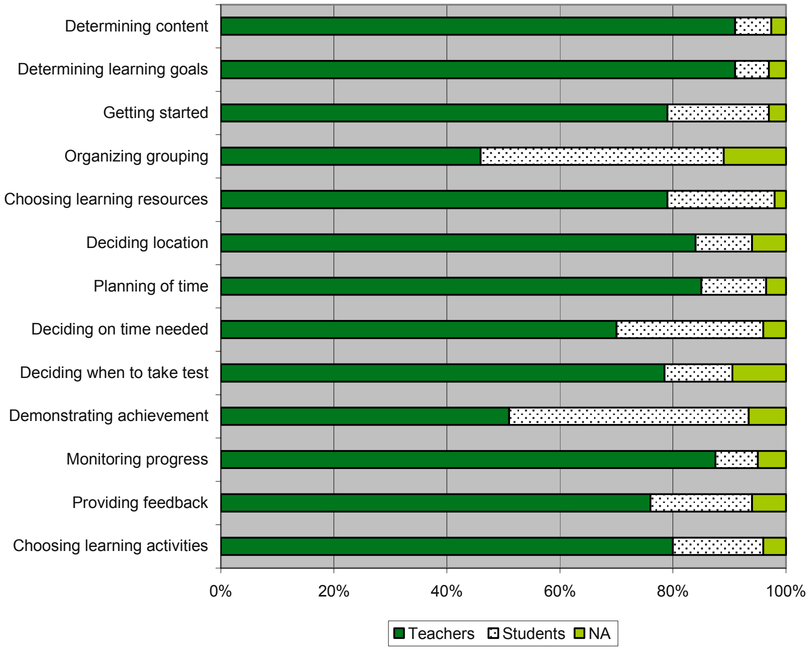
[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Teacher participation data were collected after survey administration

[4] Nationally defined population covers less than 90% of the nationally desired population.

Figure 7.4a Mathematics teachers' identification of person initiating aspects of teaching and learning



Notes:
#School participation rate after including replacement schools is below 70%
†International procedures for target-class selection were not followed in all schools
[1]School participation rate before including replacement schools is below 85%
[2]School participation rate after including replacement schools is below 85%
[3]Teacher participation data were collected after survey administration
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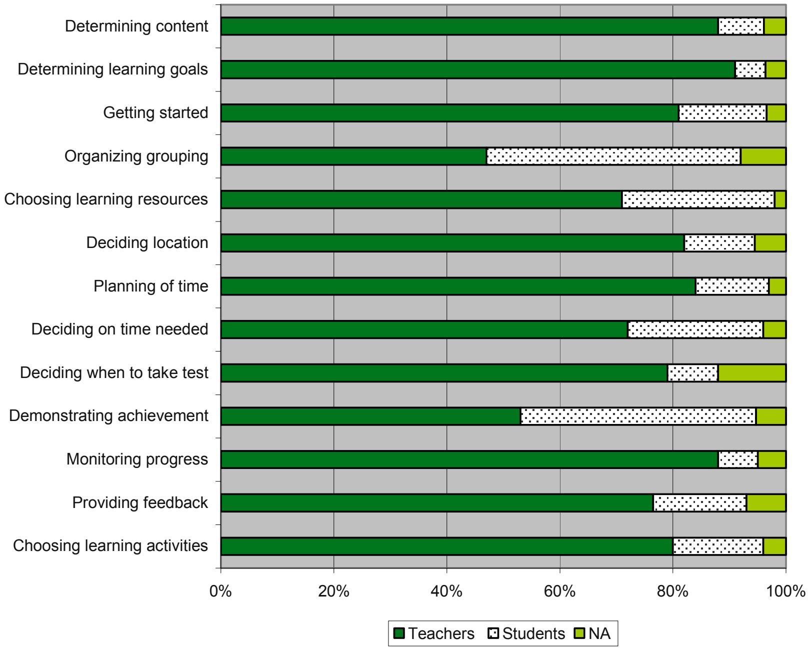
to 7.8 show the extent of cross-national variation on these four categories. Because of space constraints the figures cover mathematics teachers only; the results for science teachers appear in the online appendix (http://www.sites2006.net/appendix).

Figure 7.5 shows that a relatively large number of mathematics teachers from Moscow (18% of all mathematics teachers) and the Russian Federation (23%) reported that their students took the lead in determining the goals of their learning for the practice that each teacher had in mind. In addition, 23% of the mathematics teachers from the Russian Federation said their students were the initiators in determining the learning content of the specified activity.

Figure 7.4b Science teachers' identification of person initiating aspects of teaching and learning



Notes:
#School participation rate after including replacement schools is below 70%
†International procedures for target-class selection were not followed in all schools
1School participation rate before including replacement schools is below 85%
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3Teacher participation data were collected after survey administration
4Nationally defined population covers less than 90% of the nationally desired population.

With respect to the organization of location and time (Figure 7.6), 50% of the mathematics teachers from Slovenia, 41% from Chile, and 41% from the Slovak Republic said that students took the initiative in deciding how much time they need for learning. Of the curriculum components related to organization of the learning process, grouping in particular was seen by teachers as a student-based responsibility (Figure 7.7). Relatively large percentages of mathematics teachers in Thailand (76%), Chinese Taipei (66%), Finland (58%), Slovenia (56%), the Slovak Republic (55%), and Denmark (53%) expected students to take the initiative for organizing group work in the pedagogical practices that they had in mind.

Figure 7.8 presents the extent to which students were seen as taking the initiative in assessment practices. As observed earlier in this chapter, "demonstrating achievement" is an assessment practice wherein students are expected to take the primary initiative. This was particularly the case in Chile (72%), Ontario (59%), Chinese Taipei (58%), Moscow, (56%), Italy (55%), Alberta (53%) and the Slovak Republic (53%). A comparatively large proportion of mathematics teachers from Chinese Taipei (50%) reported their students took the lead in providing feedback.

Table 7.5 Student as initiator of aspects of teaching and learning; comparison of perceptions of mathematics teachers and science teachers who were using ICT on a weekly basis with those teachers who were using ICT during a specific period of the school year (% and (s.e.))

Change in teaching practice	Mathematics teachers		Science teachers	
	Use once a week	Use specific period in school year	Use once a week	Use specific period in school year
Determining content	07 (0.9)	06 (1.0)	08 (0.8)	09 (0.9)
Determining learning goals	09 (1.6)	05 (1.0)	05 (0.8)	06 (0.8)
Getting started	17 (1.5)	18 (1.4)	14 (1.1)	17 (1.1)
Organizing grouping	41 (2.2)	46 (1.7)	42 (1.6)	48 (1.4)
Choosing learning resources	17 (1.5)	20 (1.5)	24 (1.3)	28 (1.3)
Deciding location	10 (1.2)	11 (1.2)	12 (1.0)	12 (0.9)
Planning of time	11 (1.2)	12 (1.1)	12 (1.0)	14 (1.0)
Deciding on time needed	26 (2.1)	27 (1.5)	22 (1.2)	26 (1.2)
Deciding when to take test	13 (1.4)	11 (1.0)	11 (1.0)	08 (0.8)
Demonstrating achievement	41 (1.7)	45 (1.7)	43 (1.5)	40 (1.4)
Monitoring progress	09 (1.5)	07 (0.9)	07 (0.8)	07 (0.8)
Providing feedback	18 (1.7)	17 (1.2)	18 (1.2)	15 (0.9)
Choosing learning activities	17 (1.9)	17 (1.5)	15 (1.3)	17 (1.1)

7.8 Summary

This chapter reported the results for the 21 education systems that participated in the SITES 2006 international option. A main finding was that more Grade 8 science teachers than Grade 8 mathematics teachers reported using ICT in an extensive manner. Using ICT during a specific period (in a theme or a project) during the school year was considerably more common for both the mathematics and the science teachers in the majority of participating systems. The exceptions were Alberta, Chile, Hong Kong (science teachers only), Italy, Ontario, and the Russian Federation (mathematics teachers only).

Table 7.6 Mathematics teachers' perceptions of student as initiator in various aspects of teaching and learning (% and (SE))

	Education system	Determining content	Determining learning goals	Getting started	Organizing grouping	Choosing learning resources	Deciding location	Planning of time	Deciding on time needed	Deciding when to take test	Demonstrating achievement	Monitoring progress	Providing feedback	Choosing learning activities
	Catalonia, Spain	01 (0.8)	02 (0.9)	16 (3.3)	36 (4.3)	08 (2.9)	07 (2.2)	10 (2.2)	17 (3.2)	06 (1.8)	46 (3.7)	05 (1.4)	15 (3.0)	10 (2.5)
1	Chile	05 (1.5)	11 (2.0)	32 (2.6)	50 (3.2)	22 (2.7)	16 (2.3)	05 (1.8)	41 (3.5)	09 (1.9)	72 (2.9)	09 (1.7)	09 (1.9)	09 (1.9)
	Chinese Taipei	07 (2.6)	06 (2.1)	29 (4.1)	66 (4.5)	18 (3.4)	10 (2.7)	13 (3.0)	29 (4.0)	12 (3.2)	58 (4.3)	06 (2.1)	50 (4.6)	18 (3.5)
2	Finland	08 (3.3)	06 (2.9)	31 (4.8)	58 (6.1)	20 (4.4)	08 (2.7)	18 (4.3)	10 (3.5)	13 (3.4)	29 (5.4)	06 (2.5)	12 (3.5)	22 (4.5)
2	Hong Kong SAR	13 (2.7)	11 (2.5)	17 (2.3)	37 (3.7)	17 (2.7)	15 (3.0)	16 (2.9)	26 (3.4)	09 (2.1)	46 (3.8)	06 (1.6)	24 (2.9)	20 (3.1)
4	Israel	07 (2.7)	04 (2.0)	12 (3.2)	44 (5.2)	19 (4.4)	13 (3.0)	21 (4.0)	14 (3.3)	14 (4.1)	20 (4.0)	09 (2.9)	22 (4.7)	14 (3.4)
1	Italy	13 (2.1)	05 (1.4)	13 (2.3)	40 (3.0)	25 (3.0)	14 (2.3)	15 (2.5)	23 (2.9)	15 (2.5)	55 (3.5)	10 (1.7)	07 (1.4)	08 (1.6)
1, 3	Japan	05 (3.3)	10 (4.6)	15 (5.4)	05 (3.4)	12 (5.7)	07 (3.7)	02 (2.2)	10 (4.6)	02 (2.2)	07 (3.9)	05 (3.3)	07 (3.9)	19 (6.6)
2	Ontario Province, Canada	09 (2.1)	08 (1.8)	19 (2.3)	30 (3.0)	23 (3.0)	05 (1.4)	13 (1.9)	23 (2.8)	08 (1.9)	59 (2.9)	14 (2.9)	11 (1.9)	16 (2.6)
	Slovak Republic	01 (0.8)	01 (0.7)	04 (1.4)	55 (3.9)	19 (2.9)	09 (2.2)	04 (1.4)	41 (3.9)	29 (3.3)	53 (3.6)	10 (2.5)	25 (3.2)	14 (2.5)
	Slovenia	01 (0.7)	02 (1.1)	11 (2.3)	56 (4.0)	22 (2.8)	11 (2.2)	09 (2.1)	50 (2.9)	11 (2.1)	21 (2.6)	04 (1.3)	16 (2.7)	27 (3.2)
†, 2	Alberta Province, Canada	06 (2.0)	05 (2.3)	12 (3.0)	32 (3.8)	20 (3.4)	10 (2.8)	20 (3.2)	26 (3.7)	11 (2.4)	53 (4.2)	08 (2.5)	12 (3.0)	13 (2.9)
#	Denmark	13 (2.4)	05 (1.5)	06 (1.9)	53 (3.7)	23 (2.9)	25 (3.0)	28 (3.5)	15 (2.4)	03 (1.3)	37 (3.8)	15 (2.7)	11 (2.2)	33 (3.6)
#	Estonia	11 (4.4)	04 (2.6)	25 (5.8)	41 (7.1)	14 (4.6)	16 (4.8)	14 (4.4)	14 (4.1)	25 (5.6)	41 (6.4)	04 (2.4)	12 (4.2)	19 (5.3)
#	France	02 (1.2)	01 (0.9)	10 (3.1)	37 (4.1)	02 (1.2)	03 (2.0)	11 (2.7)	17 (3.7)	07 (2.8)	29 (4.6)	11 (3.2)	26 (4.8)	02 (1.1)
†, 2	Lithuania	03 (1.2)	06 (1.8)	20 (3.4)	42 (3.7)	26 (3.1)	30 (3.5)	22 (3.0)	28 (3.4)	22 (3.3)	36 (3.7)	14 (2.5)	09 (2.0)	16 (2.8)
†	Moscow, Russian Federation	11 (2.4)	18 (2.6)	19 (2.6)	22 (3.6)	29 (3.2)	13 (2.4)	28 (3.1)	18 (2.6)	12 (2.5)	56 (3.9)	11 (2.2)	27 (3.4)	17 (2.7)
#	Norway	05 (1.6)	05 (1.6)	02 (0.9)	31 (3.9)	22 (3.2)	07 (2.1)	12 (2.7)	11 (2.4)	11 (2.3)	37 (4.2)	12 (2.5)	12 (2.5)	24 (3.6)
†	Russian Federation	22 (3.6)	23 (3.8)	16 (3.5)	24 (4.1)	25 (5.0)	13 (2.9)	15 (3.7)	21 (3.9)	19 (5.0)	50 (4.0)	18 (3.4)	37 (4.7)	17 (4.6)
†	South Africa	03 (1.8)	07 (3.8)	11 (4.0)	21 (5.6)	08 (3.2)	07 (3.2)	03 (1.9)	06 (2.7)	07 (3.0)	37 (7.0)	00 (0.0)	11 (3.9)	00 (0.0)
†, 1	Thailand	11 (2.6)	04 (1.5)	11 (2.7)	76 (3.6)	28 (3.3)	32 (4.0)	11 (2.5)	13 (3.1)	17 (2.9)	10 (2.6)	07 (2.2)	23 (3.2)	19 (3.1)

Notes: Value labels for the response categories: 1=never, 2=sometimes, 3=often, 4=nearly always

[#] School participation rate after including replacement schools is below 70%

[†] International procedures for target-class selection were not followed in all schools

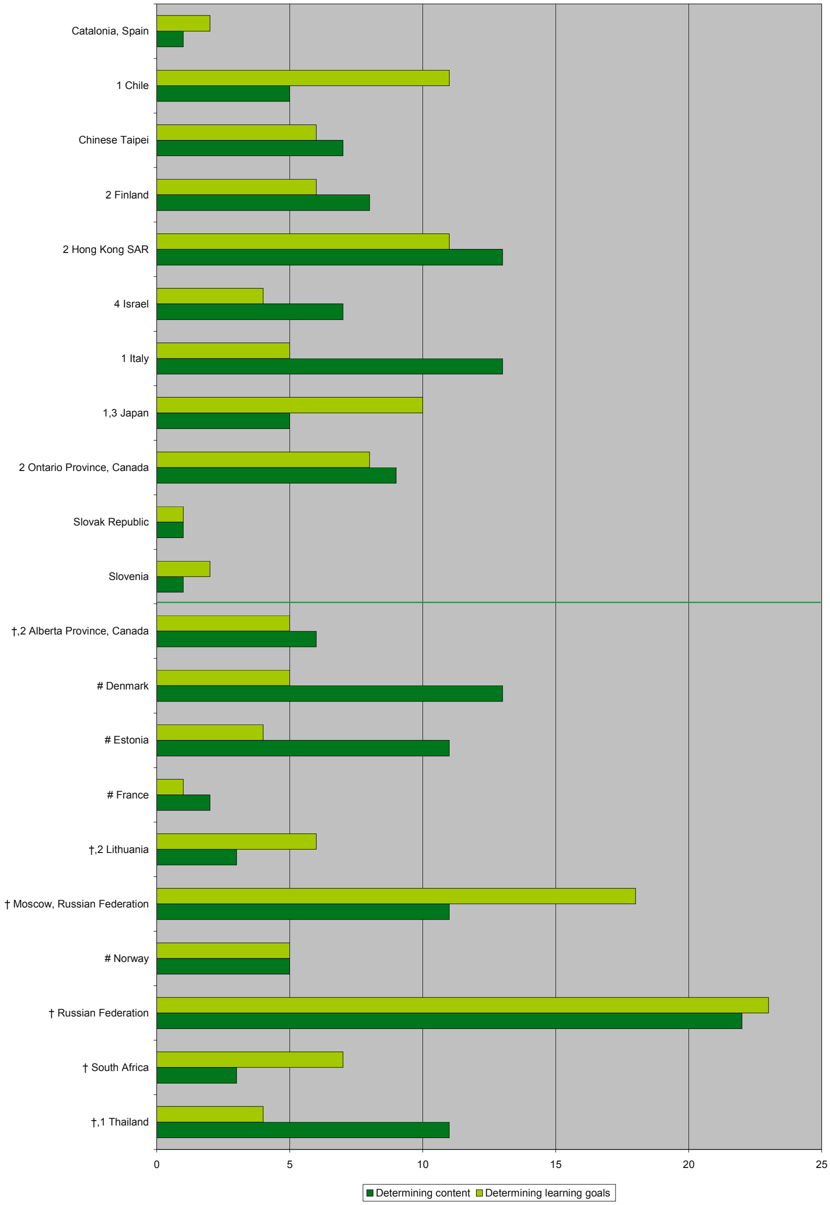
[1] School participation rate before including replacement schools is below 85%

[2] School participation rate after including replacement schools is below 85%

[3] Teacher participation data were collected after survey administration

[4] Nationally defined population covers less than 90% of the nationally desired population.

Figure 7.5 Percentages of mathematics teachers reporting that their Grade 8 students initiated the content and learning goals of the specified pedagogical activity



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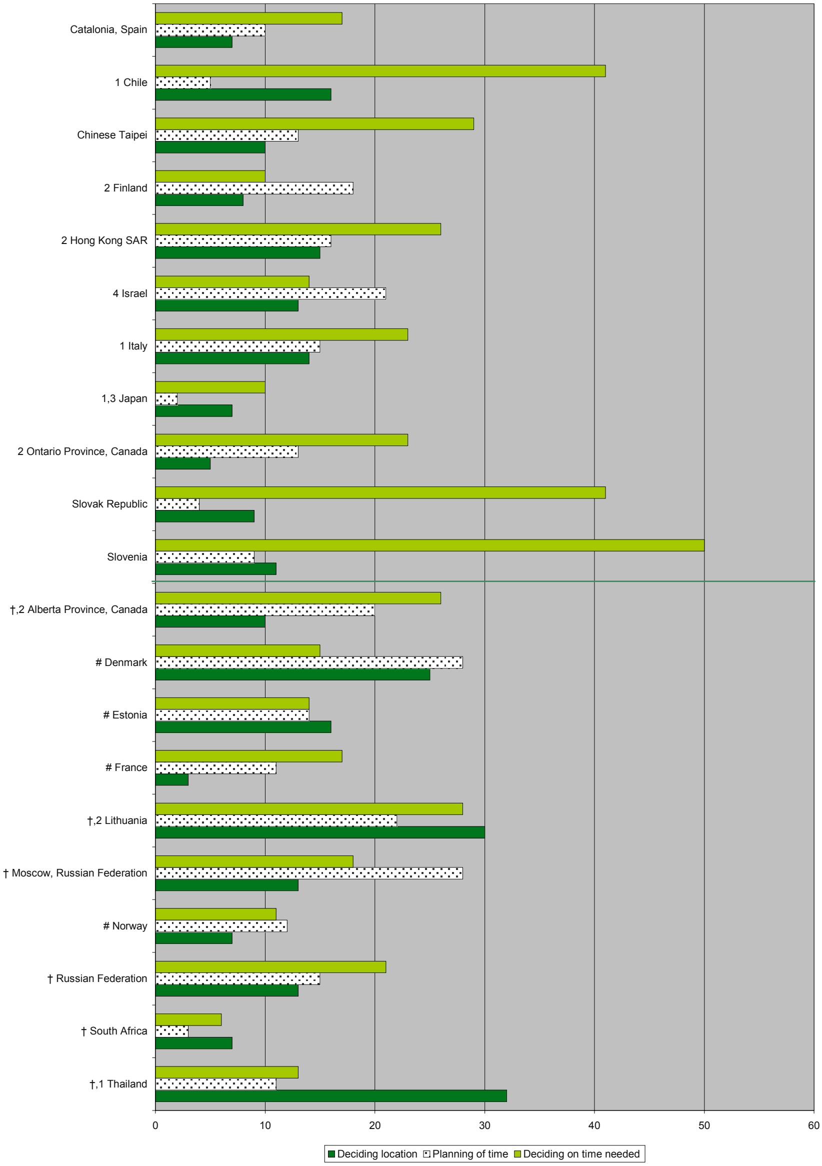
3 Teacher participation data were collected after survey administration
4 National defined population covers less than 90% of the national desired population.

Figure 7.6 Percentages of mathematics teachers reporting that their Grade 8 students initiated determination of the location, planning of time, and time needed for learning content related to the specified pedagogical activity



Notes: # School participation rate after including replacement schools is below 70%

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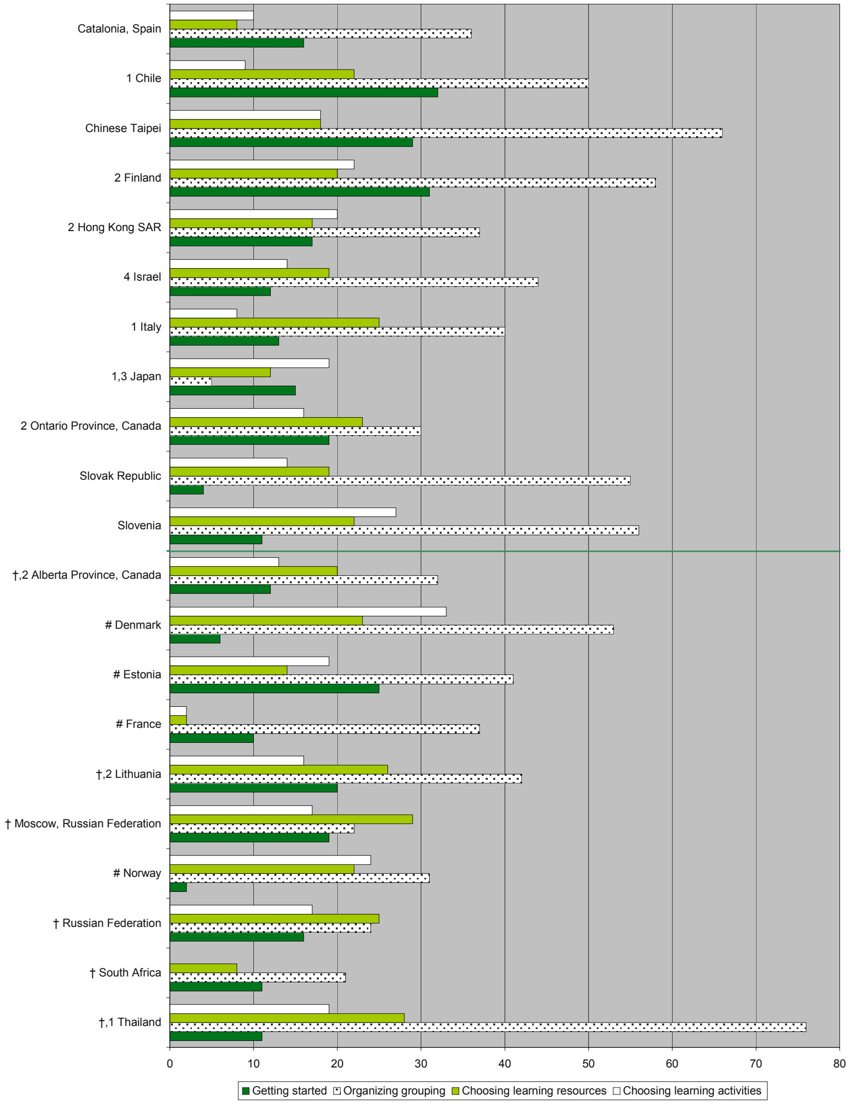
2 School participation rate after including replacement schools is below 85%

3 Teacher participation data were collected after survey administration

4 National defined population covers less than 90% of the national desired population.

Figure 7.7 Percentages of mathematics teachers reporting that their Grade 8 students initiated getting started on, choosing learning resources for, organizing grouping, and choosing learning activities related to the specified pedagogical activity



Notes: # School participation rate after including replacement schools is below 70%

† International procedures for target-class selection were not followed in all schools

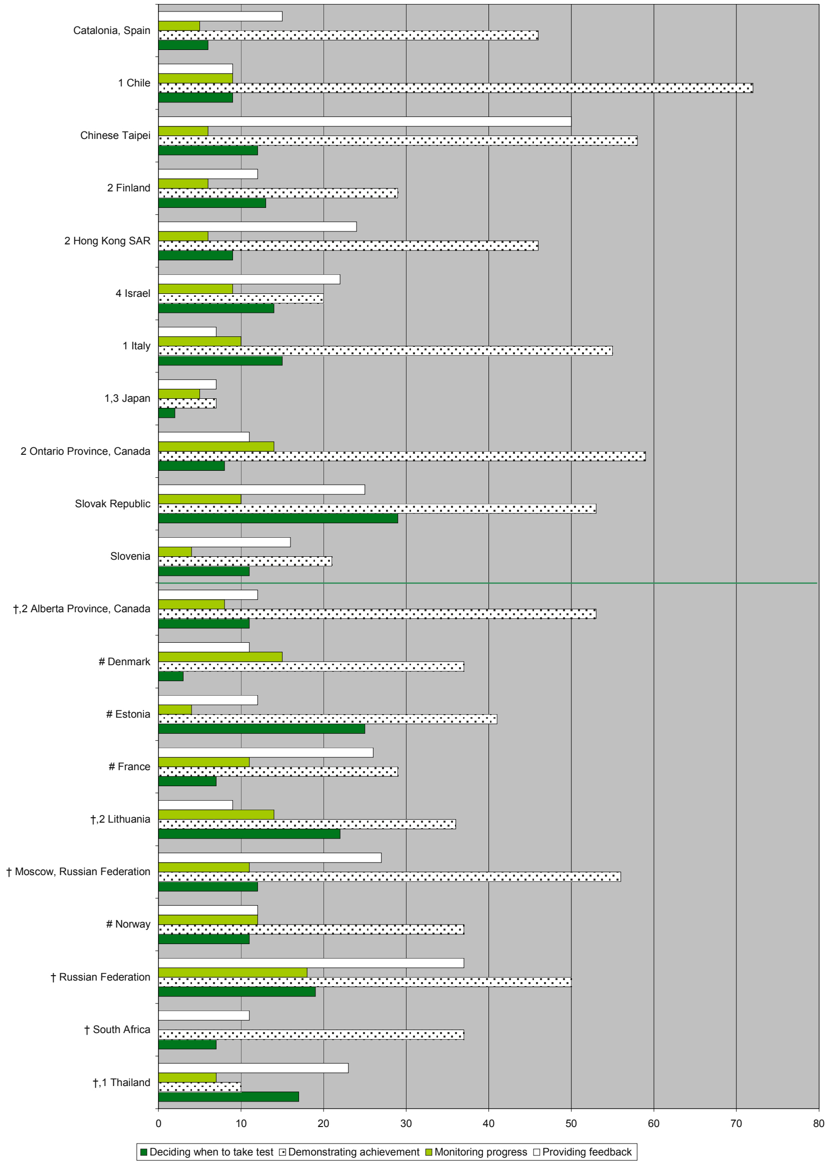
1 School participation rate before including replacement schools is below 85%

2 School participation rate after including replacement schools is below 85%

3 Teacher participation data were collected after survey administration

4 National defined population covers less than 90% of the national desired population.

Figure 7.8 Percentages of mathematics teachers reporting that their Grade 8 students initiated deciding when to take a test, demonstrate achievement, monitor progress, and provide feedback in relation to the specified pedagogical practice



Notes: # School participation rate after including replacement schools is below 70%

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2 School participation rate after including replacement schools is below 85%

3 Teacher participation data were collected after survey administration

4 National defined population covers less than 90% of the national desired population.

Both populations of teachers observed in relation to the pedagogical practice they had in mind an increase not only in their students' motivation to learn but also in their students' ICT-skills, information-handling skills, and subject-matter knowledge. The teachers also reported that using ICT in their teaching had increased the availability of new content and led to more varied learning activities and resources. More than half of the teachers mentioned that their ICT-use had increased the quality of their instruction and coaching, increased their ability to adapt their teaching to individual students, increased their self-confidence, and increased collaboration among their students. However, more than half of the teachers also reported an increase in the time they needed for lesson preparation. On most of these aspects, more of the teachers using ICT on a weekly basis reported changes than did the teachers using ICT during a specific period in the school year. This latter observation suggests that frequent use of ICT contributes to change in educational practice, a surmise that aligns with the findings of the Apple Classrooms of Tomorrow Project (Sandholtz, Ringstaff, & Dwyer, 1997).

Given the changes in teaching practices observed in this chapter, it would seem reasonable to assume a change in the distribution of responsibilities between teachers and students. However, the analysis showed that, in general, the teachers were still the main initiators of teaching and learning activities in the pedagogical practice they each had in mind. The only activities in which students took the lead were organizing grouping and demonstrating achievement, but even here less than half of both sets of teachers reported this situation.

According to the results of all three questions of the international option, teachers from some education systems (particularly Chile and Thailand) reported a relatively high number of changes relevant for the information society arising out of their use of ICT within their teaching and learning practices. Conversely, teachers from other education systems (notably Finland and Japan) reported relatively few such changes.

Chapter Eight

In Search of Explanations

Nancy LAW

Findings from the SITES 2006 study related to system-, school-, and teacher-level factors pertaining to ICT-use in classrooms were reported in the previous chapters. The results reported in Chapter 6 also indicate that the pedagogical orientation evident in ICT-using teacher practices matters. The findings associate significantly with the kinds of impact ICT-use have on students' learning outcomes. This chapter seeks to shed more light on these findings by exploring what factors at the school level relate to the magnitude of different ICT-using teacher-practice orientations in schools. Some initial explorations on this have been conducted using two approaches: (1) correlation analysis of the mean ICT-using teacher-practice orientation scores at the system level with the corresponding means for some school-level factors; and (2) multilevel analysis relating the ICT-using lifelong-learning- oriented practices of a teacher with the contextual factors at the teacher's school. Findings from both analyses are reported in this chapter.

8.1 Correlational analysis of ICT-using teacher practices with school-level conditions at the system level

As a first-level preliminary exploration, correlations of the overall system means for each of the three ICT-using pedagogical orientations with the corresponding means in six of the key school-level factors were

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computed. The six factors were the school principal's vision for how ICT could be used to support lifelong-learning pedagogy, his or her priority for leadership development, the student–computer ratio, technical support in minutes per student, and the general pedagogical and technical support available for ICT-use.

As can be seen from Table 8.1, the mean lifelong-learning orientation in ICT-using teacher practices significantly correlated with the means of the school factors analyzed, namely principal's vision for ICT-use to support lifelong learning, technical support for ICT-use and the principal's priority for leadership development. This indicates that systems high in their mean levels of lifelong-learning orientation in ICT-using teacher practices were also high in these three aspects in schools. In terms of school-level conditions, the means of the principals' vision of ICT-use to support lifelong learning, the mean levels of technical and pedagogical support available, and the mean priority given by the principal for leadership developments in the school were variously significantly related with some of the ICT-using pedagogical orientations.

Table 8.1 Correlations of system-level means of specified school-level factors and the ICT-using teacher-practice orientations of science teachers

School factors	Pedagogical orientation in ICT-using teacher practices		
	Traditionally important	Lifelong learning	Connected-ness
Principal's vision for ICT-use to support LLL	0.53	0.84 **	0.72 **
Student–computer ratio	0.05	0.51	0.34
Technical support in minutes per student per week	0.21	0.50	0.33
Technical support for ICT-use	0.69 *	0.77 **	0.36
Pedagogical support of ICT-use	0.80 **	0.45	0.08
Principal's priority for leadership development	0.38	0.64 *	0.55

Notes:
Only the 12 systems for which the teacher questionnaire data met the IEA minimum participation rate and followed all required administrative procedures in the data-collection process
* Correlation is significant at 0.05 level (2-tailed)
** Correlation is significant at 0.01 level (2-tailed).

It must be emphasized that these correlations are *not* about whether a teacher's practice relates to the school conditions under which he or she teaches. Exploring this issue requires multilevel modeling. Accordingly, some analysis of this kind has been conducted and is described in the next section. The correlations in Table 8.1 concern teacher practice and school conditions as system-level characteristics. For example, the strongest correlation between the mean lifelong-learning teacher-practice score and the mean vision of the principals for ICT-use to support lifelong learning shows that teachers in systems where the principals generally had a strong vision for ICT-use to support lifelong learning pedagogy also generally showed a higher lifelong-learning orientation in their ICT-using practices, and vice versa.

If we take the view that these school-level conditions influence teacher-practice orientations, we can interpret these results to indicate that system-wide policies that foster, among principals, the development of a stronger vision for ICT-use to support lifelong learning may create conditions that bring about a general increase in the lifelong-learning orientation of teachers' ICT-using practices within the system. By following the same line of reasoning, we can see that these results also indicate that system-wide policies designed to improve the general level of technical and pedagogical support for ICT-use and to encourage principals to make leadership development in their schools a stronger priority may make teachers more inclined to use ICT in their various practices, particularly those associated with the lifelong-learning orientation. However, given the many system- and school-level factors that act in and interact with teachers' pedagogical ICT-use, these correlations should be seen as exploratory in nature and interpreted with caution.

The results in Table 8.1 also show that no significant correlation emerged between the ICT-using teacher-practice scores and the mean student–computer ratio or the mean technical-support time in minutes per student per week at the system level. As such, there is no statistically significant evidence that systems with a lower mean student–computer ratio or a higher mean technical-support time per student will correlate any more strongly with the three orientations related to teachers' pedagogical use of ICT. However, this does not mean that improving these contextual factors will not affect teachers' ICT-using practices within the system.

It should also be noted that this correlational analysis was limited to 12 of the participating systems. The teacher-questionnaire data for each of these systems met the IEA minimum participation rate, and each system followed all required administrative procedures during the data-collection process.

8.2 Multilevel modeling of ICT-using teacher practices and school-level conditions

As described in the previous section, multilevel modeling was a useful means of exploring the relationship between contextual factors at the school level and teachers' ICT-using practices because it allows the data collected at the teacher level to be linked with those collected at the school level. In fact, multilevel modeling is a more appropriate method for use in relational analysis when the data are hierarchically structured, as has been the case with the SITES 2006 design. This section presents the results from two sets of multilevel analysis with the aim of shedding light on the relationship between the six school-level factors included in the previous analysis and the teachers' scores for lifelong-learning ICT-using teacher practices (ICT-TP-LLL scores). Because the system level is included in this multilevel analysis, the data used are again from the 12 systems for which the teacher questionnaire data met the IEA minimum participation rate and which followed all required administrative procedures during the data collection phase. Before reporting on the findings, I provide here a very brief description of multilevel modeling within the context of this study.

8.2.1 Multilevel modeling on hierarchical data

The data collected in SITES 2006 were hierarchically structured by design. The 35,367 teacher questionnaires, 7,581 principal questionnaires, and 7,501 technical questionnaires collected from 8,702 schools in the 22 systems participating in this study did not mean that random samples were drawn from the populations of all teachers, principals, and ICT-coordinators in the 22 participating systems. Instead, schools (and hence principals and ICT-coordinators) were sampled randomly within systems, and two to four mathematics teachers and science teachers teaching at the target grade were respectively selected from each of the sampled schools. Schools within the same education system may be more alike in many of their contextual characteristics, such as ICT-infrastructure, leadership practices, and professional development opportunities available. Likewise, the relationship between school-level factors and teachers' ICT-using practices may not be homogeneous across systems. Multilevel analysis can model such relationships into two components—one being a relationship that holds between school factors and teacher practice across all systems and the other component as variable across those systems. A statistical software, *HLM* (Raudenbush, Bryk, Cheong, Congdon, & du Toit, 2004), is used in carrying out the multilevel modelling in this study.

For the purpose of the present analysis, a three-level model was deemed the most appropriate because teacher data are nested within schools within systems. The Level-1 model represents the relationships among the teacher-level variables, the Level-2 model captures the influences of the school-level factors, and the Level-3 model incorporates system-level effects.

8.2.2 Three-level modeling of teachers' ICT-TP-LLL orientation scores on individual school-level factors

As a first-level exploration, a very simple three-level analysis that modeled teachers' ICT-TP-LLL orientation scores on only one school-level factor at a time was constructed. No predictor variable was introduced at the teacher level or the system level. Six of these models were computed, one for each of the following six school-level predictors listed in Box 8.1.

Box 8.1 Meaning of the abbreviations for the six school-level predictors included in the multilevel analysis models

School level predictors (sch_factor)	Meaning of predictor variable
VSICTLLL	Principal's vision for ICT-use to support LLL pedagogy
STUCOR	Student–computer ratio
SUPP_MIN_PWPS	Technical support in minutes per student per week
TECHSUP	Technical support
PEDASUP	Pedagogical support
LEADERSHIP	Principal's priority for leadership development

To avoid going into statistical details, we can present the model explored in the following simplified general form:

ICT-TP-LLL = B00 + B01 * sch_factor + R0 + E ---- (1)

where

B00 is the intercept,
B01 is the coefficient for the school-level predictor,
R0 is the random error at the school level, and
E is the random error at the teacher level.

This very simple model includes only one predictor variable at the school level. The parameter of interest in the model is B01 because of the need to determine if a significant correlation would emerge between the sch_factor being examined and the ICT-TP-LLL score of the teacher. As mentioned earlier, the SITES 2006 data are hierarchically organized such that schools are nested within education systems. Given the likelihood of the relationship between the sch_factor and ICT-TP-LLL varying from system to system, B01 was further broken down into two components—a fixed part (G01) and a random part (U01), such that:

$$B00 = G000 + U00 \quad \text{---- (2)}$$
$$B01 = G010 + U01 \quad \text{---- (3)}$$

where

G000	is the fixed component of the intercept
U00	is the component of the intercept that varies across systems
G010	is the correlation coefficient (slope) for the school factor that is the same for all systems (hence labeled as fixed effect), and
U01	is the component of the slope that varies across systems.

If the *p*-value of G010 turned out to be <0.05 for a particular sch_factor, that factor would be a statistically significant predictor of ICT-TP-LLL. If U01 was found to be statistically significant, the relationship between sch_factor and ICT-TP-LLL would be statistically different for different education systems; otherwise, the relationship would be statistically similar. Table 8.2 presents the results of the analyses for the six models investigated in relation to the 12 systems included in the analyses. Because we are interested only in B01—the relationship between school-level factors and ICT-TP-LLL—only the results for the variables contained in equation 3 are reported here.

The *p*-values listed in Table 8.2 indicate that the fixed effects of the school-level predictors (G010), with the exception of the student–computer ratio (STUCOR), were significantly and positively related to ICT-TP-LLL. This is a very important finding because it clearly shows that these five school conditions (principal's vision for ICT-use to support lifelong-learning pedagogy, principal's priority for leadership development, technical support in minutes per student per week, and technical and pedagogical support for ICT-use in teaching and learning) were significant predictors of the lifelong-learning orientation of the ICT-using practices of the mathematics and the science teachers within the same school. Hence, policies designed to promote the use of ICT for lifelong learning pedagogy in classrooms should aim to improve these school-level conditions.

Table 8.2 Summary of key results for the six single-factor three-level analyses

School-level predictors (sch_factor)	Fixed effect (G010)		Random effect (U01)	
	Coefficient	*p* -value	SD	*p* -value
VSICTLLL	0.12	0.00	0.07	0.01
STUCOR	-0.43	0.16	0.53	0.22
SUPP_MIN_PWPS	0.25	0.02	0.27	0.06
TECHSUP	0.10	0.01	0.05	0.01
PEDASUP	0.08	0.00	0.01	0.30
LEADERSHIP	0.12	0.01	0.07	0.02

The coefficient for STUCOR was negative, indicating that lower computer access (i.e., a higher student–computer ratio) was a negative predictor of ICT-TP-LLL. However, the *p*-value for this coefficient was >0.05 (*T*-ratio = -1.518, *df* = 11), indicating that the relationship was not statistically significant. An interpretation of this finding is that improving computer access *alone* was not having a statistically significant positive influence on the teachers' ICT-using lifelong-learning practices.

The important parameter to examine for the results of the random effect (U01) of the models is the *p*-value because the model did not include system-level predictors. We can see from Table 8.2 that the *p*-value for U01 was >0.05 for three of the school factors: student–computer ratio, technical support time, and the availability of pedagogical support for ICT-use. The implication of this result is that, despite the very large diversities in terms of the actual status of these conditions in schools in the different participating systems (as reported in Chapter 4), the relationship between these factors and the teachers' lifelong-learning orientation in their ICT-using practices was no different. This finding has very important policy implications. With regard to student–computer ratio, the analysis reveals that the coefficient (G01) was not statistically significant and that this non-significant relationship was the same for all 12 systems, irrespective of the actual level of computer access, which varied from a low of 38.5 in Chile to a high of

6.09 in Hong Kong. It appears that improvements in computer access per se within a school do not predict an increase in the lifelong-learning orientation of teachers' ICT-using practices.

For the availability of pedagogical support and technical support time per student, both of the fixed-effect coefficients (G010) were statistically significant, but the random-effect coefficients were not. This finding implies that the strengths of the relationships were statistically the same for the 12 systems, despite the wide diversities in the actual availability of these two factors across systems. These findings again have profound policy implications. In the case of pedagogical support for ICT-use, and irrespective of the fact that the mean levels as reported by principals in these systems varied from a low of around 2.1 in Catalonia to about 3.2 in Hong Kong (2=a little, 3=somewhat, and 4=a lot), an increase in the mean level of pedagogical support available in a school was associated with the same proportional increase in teachers' mean ICT-TP-LLL score. Similarly, the analysis revealed that an increase in average technical support time in minutes per student per week available was associated with the same proportional increase in teachers' ICT-TP-LLL score, even though the actual level of support available varied from a high of about 6.54 minutes in the Slovak Republic to a low of about 1.82 in Chinese Taipei.

For the other three school-level factors—principal's vision, availability of technical support, and the principal's priority for leadership development in his or her own school—the p-values of the random-effect coefficient were <0.05, indicating that while we can identify a statistically significant common positive relationship in the one-factor model, the variability of the coefficient across systems (U01) was statistically significant.

8.2.3 Three-level modeling of teachers' ICT-TP-LLL orientation scores on all six school-level factors

The analyses of the three-level models reported in the previous section were conducted on the six school factors independently in six separate models. This section involves exploration of a more complex model, in which the first step was to introduce the school-level factors into the model at the same time. The expectation here was that the coefficients obtained for the fixed effects would be different from the results reported in the previous section because these six factors were unlikely to be totally independent. Further, in allowing meaningful comparison of the magnitude of the coefficients, this step would reveal the relative strengths of the various school-level factors.

In addition to the six school-level factors, a system-level predictor—the mean amount of experience that schools had with using ICT for pedagogical practices (ICT-EXP)—was introduced into the model, and the mean number of years of ICT-using experience for each of the 12 participating systems was divided into two groups—one with a mean experience of more than 7.1 years and the other with a mean experience below that number of years. The next step was to create a dummy variable, ICT_EXP, so that a value of 0 could be assigned to systems with a mean ICT-experience below 7.1 years (referred to as "short ICT-EXP") and a value of 1 assigned to those systems above this number (referred to as "long ICT-EXP'), thereby allowing us to determine if the relationships between the school factors and the teachers' ICT-TP-LLL would differ for systems with different mean levels of experience of ICT-use. A simplified general form of the three-level model investigated can be represented as:

$$\begin{aligned}\text{ICT-TP-LLL} = \; & \text{B00} + \text{B01} * \text{VSICTLLL} + \text{B02} * \text{STUCOR} + \\ & \text{B03} * \text{SUPP\_MIN} + \text{B04} * \text{TECHSUP} + \\ & \text{B05} * \text{PEDASUP} + \text{B06} * \text{LEADERSHIP} + \text{R0} + \text{E} \qquad \text{---- (4)}\end{aligned}$$

This model is very similar to equation (1) above, except that all six factors, rather than just the one sch–factor, were introduced into the model at the same time. Further, the following seven Level-3 equations were also included in the model in order to take account of the dummy variable ICT_EXP at the system level.

$$\text{B00} = \text{G000} + \text{G000}*(\text{ICT\_EXP}) + \text{U00} \qquad \text{---- (5)}$$

$$\text{B01} = \text{G010} + \text{G011}*(\text{ICT\_EXP}) + \text{U01} \qquad \text{---- (6)}$$

$$\text{B02} = \text{G020} + \text{G021}*(\text{ICT\_EXP}) + \text{U02} \qquad \text{---- (7)}$$

$$\text{B03} = \text{G030} + \text{G031}*(\text{ICT\_EXP}) + \text{U03} \qquad \text{---- (8)}$$

$$\text{B04} = \text{G040} + \text{G041}*(\text{ICT\_EXP}) + \text{U04} \qquad \text{---- (9)}$$

$$\text{B05} = \text{G050} + \text{G051}*(\text{ICT\_EXP}) + \text{U05} \qquad \text{---- (10)}$$

$$\text{B06} = \text{G060} + \text{G061}*(\text{ICT\_EXP}) + \text{U06} \qquad \text{---- (11)}$$

Equation (5) concerns the intercept B00 for the model in equation (4). Each of the other six equations gives the model for the respective coefficient of the relevant school factor. For example, equation (6) provides a breakdown of the parameters modeled for the school-level factor VSICTLLL. The fixed effect on VSICTLLL for systems with short ICT-EXP (for which ICT-EXP=0) is G010; for systems with long ICT-EXP (for which ICT_EXPT=1), it is G010+G011. U01 is the random effect across systems.

The key coefficients related to the school-factor variables in the model, that is, the coefficients in equations 6 to 11 and their respective *p*-values resulting from the analysis, are presented in Table 8.3. As can be seen, the *p*-values for the fixed effects applicable to all systems were significant for only three variables—STUCOR, TECHSUP, and PEDASUP. This finding is very different from the findings reported in Table 8.2 for the six single-factor three-level analyses. Here, all school-level factors other than the student–computer ratio were found to have a significant relationship with ICT-TP-LLL. The difference indicates that these six factors relate to each other in a way that means the relationships with some of the factors become no longer significant when all six factors are considered together. For example, it is likely that both TECHSUP and SUPP_MIN_PWPS are strongly correlated and that TECHSUP would show a much stronger correlation with ICT-TP-LLL. Also, the fixed-effect coefficients for VSICTLLL and LEADERSHIP were no longer significant in this model, possibly because the impacts of these factors had already largely exhibited through STUCOR, TECHSUP, and PEDASUP.

Another important result from this analysis is that infrastructure matters (the coefficient G020 for STUCOR, the student–computer ratio, is statistically significant), as became evident when all the other factors were held equal. This finding differs from the results presented in Table 8.2 that show the coefficient for STUCOR was not statistically significant when the model contained only this school factor. Thus, a statistically significant positive association between improved computer access and teachers' ICT-TP-LLL scores emerged when other factors such as pedagogical and technical support were held constant. This finding has deep policy implications.

A further noteworthy observation from Table 8.3 is that none of the *p*-values for the coefficients of the Level-3 fixed effects applicable to systems with long ICT-EXP turned out to be significant (i.e., all of the *p*-values were >0.05). As such, there is no evidence that the effect of these six factors on teachers' ICT-TP-LLL was any different in terms of whether the education system had only just started to introduce ICT into classrooms or whether the system had a mean history of ICT-use longer than 7.1 years in its schools. This is a very important finding, indeed, because it offers no evidence to suggest that, within an education system, policies aimed at supporting the achievement of 21st-century learning goals in schools should be "staged" because of the different histories of ICT- implementation in that system.

Table 8.3 Summary of the key results in the three-level analysis with six school factors and one system variable

School-level predictors (sch_factor)	Level-3 fixed effects applicable to all systems			Level-3 fixed effects applicable to systems with long ICT-EXP			Random effects		
	Coefficient		*p*-value	Coefficient		*p*-value	SD		*p*-value
VSICTLLL	G010	-0.01	0.89	G011	0.01	0.87	U01	0.02	>.500
STUCOR	G020	-0.98	0.04	G021	-0.49	0.67	U02	0.26	0.38
SUPP_MIN_PWPS	G030	0.32	0.13	G031	-0.19	0.43	U03	0.17	0.30
TECHSUP	G040	0.08	0.03	G041	-0.02	0.62	U04	0.05	0.13
PEDASUP	G050	0.08	0.02	G051	-0.02	0.72	U05	0.02	>.500
LEADERSHIP	G060	0.08	0.12	G061	0.00	0.99	U06	0.04	>.500

An examination of the *p*-values for the random effects revealed that the only significant variable was the intercept of the model (U00). This finding indicates that no statistically significant differences would have been evident across systems in the relationship between the six school factors and ICT-TP-LLL, beyond those accounted for in the model.

8.3 Summary

Six important school-level factors generally identified in the literature as having important impacts on ICT-use in teaching were included in the reported analyses to help determine which factors actually influence the pedagogical orientation of teachers when they use ICT in their teaching. These six factors included leadership factors (principal's priority for leadership development and principal's vision for ICT-use to support lifelong learning), technology infrastructure (student–computer ratio), and support (time available for technical support for staff in minutes per week per student, general level of technical support, and general level of pedagogical support).

The analysis reported in section 8.1 indicates that, even at the country/education-system level, those systems with higher means for leadership and support showed significantly higher mean lifelong-learning orientations in their teachers' ICT-using practices. No such correlation was found for the student–computer ratio. These findings triangulate well with the findings from the first set of multilevel analyses presented in 8.2.2. When these six factors were separately modeled in a three-level model linking the school-level responses to the teachers' responses from the same school, the student–computer ratio again did not show any statistically significant relationship with the teachers' ICT-TP-LLL. However, when all six factors were introduced into the same three-level model, only the support and infrastructure factors became statistically important.

These findings suggest that the association of leadership and vision with ICT-TP-LLL is largely realized through the influence these have on support (pedagogical and technical) and technology infrastructure. The multilevel analyses also indicate that the way these factors influence teachers' ICT-using practices remains the same whether systems have a longer or a shorter history of ICT-use in their schools. Hence, there is no evidence to support a differentiated policy model for fostering use of ICT in support of lifelong-learning-oriented teacher practices that depends on integrating ICT through different stages of development. Instead, the findings support a balanced approach that pays attention not only to pedagogical and technical support but also to infrastructure and leadership development, and with both guided by a clear vision of how ICT can and should be used to support the development of lifelong learning abilities among students.

Chapter Nine

Summary and Reflections

Nancy LAW

SITES 2006 was designed and conducted within a global context of increasing policy interest in the use of ICT in schools to help students develop 21st-century skills, such as the ability to engage in collaborative knowledge creation and problem-solving with peers and experts around the world. As detailed in Chapter 2, the design of SITES 2006 was informed by the rich literature on ICT in education that points to the important influence of pedagogical orientation on the outcomes of ICT-use in teaching and learning. Hence, this study has not been a study of ICT-use per se, but a study of ICT-use within the context of the overall pedagogical practice of the teacher. The contextual factors examined in this study also include those found pertinent to supporting pedagogical change and innovation.

SITES 2006 was designed in a way that would not only help us understand the status of pedagogy and ICT-use in mathematics and science classrooms and the status of various contextual factors at work at the school- and system-levels in the participating systems, but also let us build models aimed at explaining how various contextual factors may contribute to the pedagogical use of ICT by teachers. This final chapter reports on some initial findings from explorations to build such explanatory models. In particular, it reports findings from multilevel analyses of school- and teacher-level indicators that shed light on whether some key strategic factors commonly found in ICT-related educational policies do, indeed, influence teachers' pedagogical use of

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ICT. In addition, this chapter offers teachers, school leaders, and policymakers recommendations on ways of using ICT to support the development of 21st-century abilities in learners. Before describing the findings from the relational analysis and presenting the recommendations, I begin this final chapter with an overview of the key findings reported in the previous chapters.

9.1 Summary of key findings at teacher, school, and system levels

This overview of the key findings reported in Chapters 3 to 8 is organized around four themes:

1. *Contextual factors pertinent to ICT-use and pedagogical innovation*: This theme focuses on the status of system- and school-level factors that are generally considered to have important impacts on pedagogy and ICT-use.
2. *Pedagogical practices and ICT-use*: This theme covers the extent to which 21st-century-oriented pedagogical practices are happening in mathematics classrooms and science classrooms around the world; the extent of ICT-adoption by teachers; the extent to which ICT-using pedagogical practices show 21st-century characteristics; and teachers' perceptions of the contributions that ICT-use makes to student outcomes and teaching practice in general and to the amount of satisfaction they draw from their pedagogical practices in particular.
3. *Within-level analysis of factors influencing pedagogy and ICT-use*: The focus here is on relationships between teachers' use of ICT in their teaching and their own personal characteristics, including their self-perceived ICT-competence and the status they accord a range of important conditions.
4. *Cross-level analysis of factors influencing pedagogy and ICT-use*: Analysis conducted under this theme explores relationships between school level factors and teachers' pedagogical orientation in their ICT-using practices.

9.1.1 Contextual factors pertinent to ICT-use and pedagogical innovation

SITES 2006 addressed two broad categories of contextual factors—those associated with system-level conditions and policies and those more directly related to school-level conditions. Information about the former was collected through publicly available national statistics and from a questionnaire completed by the SITES national research coordinators. Information about the latter was collected through questionnaires administered to the principals and technology coordinators of the participating schools within the 22 education systems involved in SITES 2006.

System-level factors

Chapter 3 reported on key contextual parameters at the system level in four spheres: demographics, structure, pedagogy, and ICT. A great deal of diversity and variation in all four spheres was found, but these pertained mainly to the country/system level rather than to "clusters'" of education systems. Slightly more than half of the education systems under review had centralized educational structures, with examinations and certification requirements generally the responsibility of central authorities and the primary control of funding the responsibility of the central or provincial governments. Central or provincial control of curriculum components was reported in about half of the systems, and 10 of the 22 systems had attainment standards specified for all subjects. Many of the systems, however, did not have active, centralized policies on teachers' professional development related to ICT-use or new pedagogies. More specifically, 15 of the 22 systems did not have specific ICT-related requirements for teacher certification, 13 reported no formal requirements for key types of teacher professional development, and 12 did not have a system-wide program aimed at stimulating new pedagogies.

The majority of systems had, at minimum, slightly increased their spending on ICT during the five years prior to the SITES 2006 survey, and nearly all reported some level of government funding for the provision of hardware and software. Twenty of the 22 systems reported having a system-wide policy relating to ICT in education. However, when the systems were asked to identify which of 11 specified ICT-related policy components were in place, four systems reported having none of them and two reported having all 11. Only 10 systems reported having a system-wide program regarding student ICT-related skills at the target grade (ISCED level Grade 8). This program had been implemented through one or more compulsory classes in five systems and by infusing ICT-instruction in several or all other subjects in the other five systems.

Across the relatively small number of participating systems, it appears that the more centralized systems (in terms of funding and curriculum control) were more likely to have either an official, system-wide program relating to ICT-skills or a policy on developing 21st-century skills, or both. Education systems with a low income (GDP per capita) were *not* more likely to be centralized than systems with higher incomes, nor were they more likely to have policies on ICT-use vis-à-vis ICT-skills and/or 21st-century skills.

School-level factors

Chapter 4 reported on the status of key contextual factors at the school level as reported by the school principals and technology coordinators. The factors included perceived presence of lifelong-learning pedagogy, visions for ICT-use, the presence and nature of the ICT-infrastructure, the ICT-support available within the school, and the staff- and leadership-development measures available.

Between 1998 and 2006, a marked change took place in some systems in the percentage of principals who indicated that lifelong-learning-oriented pedagogical practices were present "a lot" in their schools. In most of the 15 systems that took part in both SITES-M1 and SITES 2006, there was a general increase in the perceived presence of lifelong-learning pedagogy, with quite substantial increases evident in some of the systems that reported the lowest presence in 1998. Conversely, a decrease in presence was reported in the three systems that registered the highest presence in 1998.

When principals were asked about their pedagogical vision, they generally reported a weaker orientation for connectedness compared to traditionally important and lifelong-learning pedagogies. The mean strength of the vision for ICT-use in lifelong-learning pedagogies appeared to correlate negatively with the mean number of years that schools at the system level had experienced ICT. It is not surprising to also note that the developing countries generally reported a shorter history of ICT-use in their schools.

Large improvements in access within schools to computers and to internet were evident for all systems that participated in both SITES-M1 and SITES 2006. With the exception of one country, all participating systems reported having access to computers and the internet for supporting teaching and learning. However, there were wide diversities in terms of the ICT-infrastructure available in schools, resulting in huge differences in terms of access to computers and to the internet for students within and across the different systems. General Office, multimedia and communication applications were generally widely available, but the availability of mobile devices and smartboards were generally low. The availability of subject-based applications, emails, and learning management systems were more variable across systems. However, the relationship between availability of ICT-related resources and the perceived need for them differed according to the resource under consideration. A high level of need was perceived if availability was low in the case of email accounts, but not smartboards.

Maintenance support in schools was provided through several sources in most participating systems, and members of school staffs were often involved in addition to other sources of support, including students. The technical support available in minutes per week per student varied widely across systems. There was also wide variation in the extent to which technical support and pedagogical support were available for various student-learning activities as well as in the relative priorities given to these two kinds of support. Some systems ranked very high on their mean level of technical support available but very low on pedagogical support, and vice versa.

In most systems, a large majority of schools had no requirements on teachers to undertake any specific ICT-related professional development. The availability of different kinds of courses also differed greatly across systems. The priority principals gave to developing the leadership capacity of the school senior management for curriculum and pedagogical innovation, including fostering a common pedagogical vision among staff, also varied widely. There were considerable differences in leadership practices in schools across systems in terms of whether principals took an active role in trying to influence the pedagogical and assessment practices of teachers, and whether they tried to encourage teachers to engage in cooperative activities within and outside the school. Where the mean priority for leadership capacity development was high, the corresponding mean perceived presence of lifelong-learning pedagogical practice in schools was also high.

9.1.2 Pedagogical practices and ICT-use

Chapter 5 reported on the extent to which the mathematics and the science teachers in the participating systems had adopted 21st-century-oriented pedagogies generally and in ICT-using practices in particular. Chapter 5 also documented teachers' perceptions of the impact of ICT-use on themselves and their students generally, while Chapter 7 focused on specific pedagogical instances of ICT-use that the teachers identified as especially satisfying. These findings are summarized here to shed light on the impact of ICT-use on pedagogy and learning outcomes.

Overall pedagogical orientations

The teachers' responses reflect that they were more actively engaged than their students in various ICT-related activities. The students' less active role tended to be evident even when their teachers gave very high ratings to the importance of the corresponding curriculum goals. This finding indicates that teachers' aspirations toward the 21st-century orientations were generally higher than had been realized from analysis of their reported practices. SITES measured teachers' pedagogical-practice orientations from three *perspectives*: espoused curriculum goals, reported teacher practices, and reported student practices. A comparison of the scores for the three *orientations*—traditionally important, lifelong learning, and connectedness—revealed that, in general across the participating systems, the traditionally important orientation had the highest mean score while connectedness had the lowest. This outcome corresponds with the finding reported in Chapter 3 that the principals from the participating schools also gave their lowest priority rating to connectedness-related goals, despite both lifelong learning and connectedness being important aspects of 21st-century pedagogical practices.

The differences in scores between the traditionally important, lifelong learning, and connectedness orientations were smallest for the goal orientations and biggest for the student-practice orientation. Thus, in general, the teachers were more likely than the students to be adopting 21st-century-oriented practices. Perhaps teachers find it less risky to try out new activities themselves than to have students doing so. An interesting question is whether teachers will adopt more 21st-oriented student practices once they become more confident with the newer pedagogical approach. This question of whether we will see developmental changes toward 21st-century-oriented student practices is important from both policy and change management perspectives, and is one that definitely needs to be explored through longitudinal analysis of data from any follow-up studies conducted in the future.

Adoption of ICT and ICT-using pedagogy in mathematics classrooms and science classrooms

Given that almost 100% of the schools in 21 of the 22 participating systems reported having computer and internet access for pedagogical use, the percentage of teachers reporting that used ICT for pedagogical purposes was comparatively low. Less than half of the mathematics teachers and the science teachers in 12 and 4 systems respectively reported having used ICT with their target class. Although ICT-use was generally more prevalent among science teachers than mathematics teachers in most systems, the extent to which teachers had adopted ICT differed enormously across systems, varying from below 20% (of teachers) to over 80%.

Comparison of ICT-using practices with overall practices provided evidence that ICT-use in teaching and learning had brought about pedagogical changes in both mathematics and science classrooms. Across systems, larger variations in the relative importance of the three orientations (traditionally important, lifelong learning, and connectedness) were more evident in the ICT-using pedagogical practices than the overall practices. The relative importance of the three orientations in ICT-using teacher practice was similar to the corresponding profile in overall teacher practice in only about half of the systems. In systems where the profile changed, most showed a stronger 21st-century orientation in the ICT-using teacher practices, although there were a few instances where the opposite trend could be found.

The differences became even more prominent when the ICT-using and overall student practices were compared. With the exception of one system, there was a stronger orientation toward lifelong learning and connectedness pedagogies in ICT-using practices compared to overall student practices. A similar trend could be observed for assessment practices. In most of the participating systems, the mean percentage of ICT-use in traditionally important assessment practice reported by the mathematics and the science teachers was less than 50%, even though nearly all the teachers were using this kind of assessment in their general assessment practice. In some systems, ICT was more likely to be used to assess learning products than to be used for traditionally important assessment tasks.

Several implications can be drawn from the above findings. First of all, ICT adoption per se does not determine pedagogical orientation as evidenced by the observation that, within systems, ICT-using practices tended to exhibit a stronger traditional orientation or a stronger 21st-century orientation than an overall pedagogical orientation. Secondly, pedagogical adoption of ICT can be used positively as an opportunity to bring about the kind of pedagogical reform that is suited to the demands of the 21st-century, particularly in terms of changing student practices. Further, although the opportunities for students to use ICT in their learning activities were still not high, it is these student practices that have the potential to strongly influence changing the pedagogical practice orientation in classrooms toward one that embraces 21st-century pedagogies, particularly connectedness.

Perceived impact of ICT-use on pedagogical practices in general

Teachers' perceptions of the impacts of ICT-use on themselves and on students were generally positive and the mean levels of negative impacts were relatively low. The highest perceived impacts on teachers themselves were *ICT-skills* and *empower teaching*, while the highest perceived impact on students was also in the area of improved ICT-skills. The perceived impact of ICT on enhancing teachers' collaboration was not high. However, in some systems, the perceived impact of ICT-use on students' cognitive, metacognitive, and affective outcomes, such as inquiry skills, collaboration, and students' ability to work at their own pace, was comparable to the perceived gain in students' ICT-skills. It is noteworthy that higher levels of reported ICT-use did not necessarily equate with higher levels of perceived learning gains from ICT-use.

Perceived impact of ICT-use in instances of satisfying pedagogical practices

An international option in the teacher questionnaire asked teachers who had made extensive use of ICT in their teaching of the target class to identify and report on an instance of a pedagogical practice employing ICT that they had found particularly satisfying. Twenty-one systems participated in this option. The highest impacts of ICT-use on students in these satisfying pedagogical practices as reported by teachers were increases in students' motivation to learn, ICT-skills, information-handling skills, and subject-matter knowledge. However, about 35% of both the mathematics and the science teachers reported an increase in achievement gap among students in such practices, a proportion well beyond the 7% who reported a decrease.

More than half of the teachers reported increases in the following aspects of their own teaching practices as a consequence of ICT-use in the specific instance of satisfying pedagogical practice: availability of new content, varied learning activities and resources, collaboration among students, quality of instruction and coaching, adaptation of their teaching to individual students, self-confidence, and time needed for lesson preparation. Further, more of the teachers who used ICT on a weekly basis reported changes compared to those who used ICT only during a specific period in the school year. However, even in these examples of satisfying pedagogical practices, teachers continued to be the main initiator of teaching and learning activities.

9.1.3 Impact of ICT-use on students' and teachers' pedagogical orientation

The design of SITES is underpinned by the assumption that pedagogy matters relative to integration of ICT in teaching and learning. This is because the outcomes of integration can vary widely within and across systems. Moreover, this variation is not determined simply by the technology used. Investigations into the relationships between teachers' perceived impact of ICT-use on their students and the pedagogical orientations they adopted when using ICT provide confirmatory evidence that pedagogical orientation *does* matter. Not one significant correlation emerged from the analysis examining associations between traditionally oriented uses of ICT in teacher practices and the eight student-outcome categories. The connectedness-oriented scores showed significant correlation with self-paced learning only, and the correlation was positive. The ICT-using lifelong-learning scores, however, showed significantly positive correlations with all of the student-outcome categories except socioeconomic divide. Furthermore, the correlations were highest for inquiry and collaboration skills and lowest for traditional outcomes. This means that teachers whose response indicated they had adopted more of these 21st-century-oriented practices were also the teachers who reported higher levels of students' learning gains from ICT-use in the outcome domains deemed particularly important for the knowledge society.

The findings provide preliminary evidence that the education reform policies adopted in many countries in parallel with policies on ICT in education that promote collaboration, inquiry, and student-centered approaches to teaching and learning do help increase students' achievement of 21st-century learning outcomes, as long as the ICT-related policies are effectively implemented. However, attention also needs to be paid to the significant perceived increase in achievement gap among students that appear to arise when teachers adopt lifelong-learning orientations in their ICT-using practices.

9.1.4 Relationships between pedagogy, ICT-use, and school-level factors as perceived by teachers

Besides collecting responses about pedagogy and ICT-use, the teacher survey also contained questions relating to personal demographic characteristics and the teachers' perceptions of a variety of school-level conditions. Relational analysis on these personal and contextual factors with teachers' adoption of ICT in their teaching of the target class was reported in Chapter 6.

There was no evidence from this analysis, that age and gender per se were influencing teachers' pedagogical adoption of ICT-use. However, academic and professional qualifications, technical and pedagogical ICT-competence, and attendance at ICT-related professional development significantly and positively correlated with adoption of ICT. Of all the personal characteristics of the teacher, pedagogical ICT- competence was the best positive predictor of teachers' pedagogical adoption of ICT, a finding triangulating well with the observation that the teachers were more willing to attend pedagogical than technical professional-development activities on ICT-use. A general positive relationship was also found at the system level between a system's mean level of reported pedagogical and technical ICT-competence and the percentage of its teachers having used ICT with their target class.

In terms of obstacles to ICT-use, both school-related and teacher-related obstacles were statistically significantly associated with lowered probabilities of ICT-use by teachers in most systems. The presence of a community of practice in a school is generally taken as contributive to the emergence of pedagogical innovations in the school.

Of the four aspects of a community of practice, the perceived presence was highest for shared vision while professional collaboration and support were among the lowest. Support, however, emerged as the one most consistent positive predictors of teachers' pedagogical adoption of ICT, a finding that indicates teachers are more likely to use ICT in their teaching if they feel they are receiving support from the school—support that provides them with technical and administrative support and that offers their students access to ICT outside of class hours. Shared decision-making followed by professional collaboration were also found to be positive predictors of pedagogical ICT-use.

9.1.5 Relationships between ICT-using teacher practices and school-level factors at the system level

Exploration of teacher practice and school conditions as system-level characteristics required computation of correlations between the mean ICT-using teacher-practice-orientation scores at the system level and the corresponding means for selected school-level factors. The highest correlation to emerge from the analysis was between the lifelong-learning orientation and the principal's vision for using ICT to support lifelong learning. The mean lifelong learning orientation in ICT-using teacher practices correlated significantly with most of the means of the school factors analyzed, namely principal's vision for ICT use to support lifelong learning, technical support for ICT-use and the principal's priority for leadership development. This finding indicates that if a principal of a school has a strong vision of how and when ICT can be used to support lifelong learning pedagogy, if the technical support for ICT-use within that school is generally readily available, and if the principal gives relatively high priority to leadership development, then the teachers within that school will generally show a higher lifelong learning orientation in their ICT-using practices, and vice versa. There was no significant correlation between the ICT-using teacher-practice scores and the mean student–computer ratio or the mean technical support time in minutes per student per week at the system level. Overall, the findings suggest that system-wide policies aimed at improving the general level of technical and pedagogical support for ICT-use and encouraging principals to make leadership development a stronger priority in their schools will enhance teachers' inclination to use ICT in their different pedagogical practices, particularly those practices associated with the lifelong-learning orientation.

9.1.6 Relationships between teachers' pedagogical orientation toward ICT-using practices and the contextual conditions at their schools

Chapter 8 reported a multilevel analysis that explored relationships between the ICT-using lifelong-learning-oriented practices of the teachers who participated in SITES 2006 with the contextual factors at their schools. Analysis involving one school-level condition at a time as an explanatory variable found statistically significant positive relationships between the following five school-level factors and teachers' use of ICT when teaching: principal's vision for ICT-use to support lifelong learning pedagogy; technical support in minutes per student per week; availability of various kinds of technical support; availability of various kinds of pedagogical support; and the principal's priority for leadership development.

Although student–computer ratio did not have a significant association with teachers' use of ICT, multilevel modeling on all six school-level factors taken together found that this ratio along with availability of technical support and the availability of pedagogical support were the three factors contributing significantly to teachers' use of ICT in *lifelong-learning practices* in all 12 systems analyzed. Thus, the other three factors previously found to be significantly related to teachers' ICT-using lifelong-learning practices were no longer contributing significantly within the multilevel model, indicating that although all six factors were related to one another, the former three came out as the most dominant when all six were considered together. The findings also indicate that if all other factors were held constant, student–computer ratio would associate significantly with teachers' ICT-using practices. Further, the study found no evidence that the relationship between school-level factors and teachers' ICT-using pedagogy differed on the basis of whether the system had longer or shorter mean histories of ICT-use in their schools.

9.2 Key findings and policy implications

SITES 2006 collected very rich data not only on how teachers are using ICT in mathematics and science education at ISCED Grade 8 level but also on the wide range of school-level data that influence this use. This final section of the SITES 2006 international report presents a summary of the key findings, along with a discussion of the key policy implications arising out of them.

9.2.1 Key findings

The key findings presented here are those with important implications for policymakers, teachers, school leaders, and teacher educators:

1. Computer access is a necessary but not sufficient condition for ICT-use in learning and teaching. In all except one of the participating countries, almost 100% of the schools had computer and internet access for pedagogical use, but the extent to which teachers had adopted ICT differed enormously across systems, varying from below 20% of the teachers to over 80%.
2. Increasing the level of computer access per se does not bring about more learning experiences conducive to the development of 21st-century learning outcomes for students.
3. Teachers' pedagogical orientations, such as their understanding of the changing demands of citizens in the knowledge economy and their readiness to employ more collaborative, inquiry-oriented learning activities, to create a more open and connected learning environment, and to take on more facilitative roles, make a major difference to the way teachers utilize ICT in their classrooms.
4. As evident within most of the participating systems, ICT-use in teaching and learning brings a stronger 21st-century orientation to pedagogy in both mathematics and science classrooms.
5. ICT adoption per se does not determine pedagogical orientation as evidenced by the observation that in a few systems ICT-using practices exhibited a stronger traditional orientation.
6. The impact of ICT-use on students appears to be highly dependent on the pedagogical orientation that teachers adopt in regard to that use. Analyses of the data revealed correlations between lifelong-learning-oriented pedagogical uses of ICT in teaching and learning and perceived gains in students' 21st-century outcomes. No significant correlations were found between traditionally oriented uses of ICT and students' learning outcomes, as reported by their teachers.
7. Except for pedagogical ICT-competence, teachers' background characteristics do not appear to correlate with teachers' pedagogical use of ICT.

8. The most serious obstacles to ICT utilization in the classroom are school-related rather than student-related. The SITES data showed that the surveyed teachers identified lack of support as the most significant obstacle.
9. The most important school-level factors influencing teachers' ICT-use for lifelong-learning practices are the vision that principals have in regard to ICT-use supportive of lifelong-learning pedagogy and the technical and pedagogical support available to teachers and students. These findings held for systems with different mean lengths of ICT-using experience in their schools.
10. The extent of ICT-use depends not only on school-level factors but also on national curriculum policies as evidenced, in some systems, by the huge differences in the extent of ICT-adoption by both mathematics and science teachers within the same set of sampled schools.

9.2.2 Implications of the SITES 2006 findings for ICT-related education policies

The findings of this study give rise to several pertinent policy recommendations:

1. Policies on ICT in education must clearly identify the development of 21st-century student outcomes as an important goal and emphasize that the priority for ICT-use should be given to lifelong-learning-oriented student and teacher practices.
2. ICT-related professional development for teachers should give priority to developing pedagogical rather than technical ICT-competence.
3. The availability of both pedagogical and technical support at the school level is important to ensure that teachers actually use ICT in their teaching. School-level leadership must therefore make provision of such support a high priority within its vision for learning and teaching in the school.
4. Improvements in the level of student access to computers should also be included as a core element of an IT in education policy, as inadequate access will adversely affect ICT-use even when all other conditions are favorable.
5. Policies that adopt a balanced, holistic approach catering for leadership development, professional development, pedagogical and technical support for ICT-use as well as improved ICT-

infrastructure in schools will be more successful than policies focusing on one or two strategic areas.

6. Systems need to adopt a balanced approach to the use and provision of ICT no matter how long the history of ICT-adoption in respective schools. SITES 2006 offered no data to suggest that countries that have shorter histories of ICT-adoption in their schools need to develop different strategic emphases.
7. To ensure that ICT-use develops desired 21st-century abilities among students, ICT-related education policy must work in tandem with the broader curriculum framework and overall education policy to promote a lifelong-learning pedagogical orientation.
8. SITES 2006 data show that the perceived impacts of ICT-use on students were highly related to the pedagogical orientation adopted by the teacher when using ICT. Research on assessing students' learning outcomes in the area of 21st-century competences and how these outcomes relate to teachers' pedagogical orientation should be included as a high policy priority. Such an approach is necessary in order to provide clearer evidence on the extent to which students exhibit 21st-century skills when ICT is used in authentic learning and/or problem-solving situations and to determine if teachers' pedagogical approaches really do influence students' learning outcomes, and if so, how.
9. Longitudinal studies that provide regular monitoring of school-level factors and teachers' ICT-use in different subject areas should be included in ICT-related education policies to provide a basis for informed policy decisions.

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Appendix A

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Appendix B

Systems participating in the three SITES modules

Education system	SITES-M1	SITES-M2	SITES 2006
Australia		✓	
Belgium (French)	✓		
Bulgaria	✓		
Canada	✓	✓	
Alberta Province [CAB]			✓
Ontario Province [COT]			✓
Chile [CHL]		✓	✓
China Hong Kong [HKG]	✓	✓	✓
Chinese Taipei [TWN]	✓	✓	✓
Cyprus	✓		
Czech Republic	✓	✓	
Denmark [DNK]	✓	✓	✓
England		✓	
Estonia [EST]			✓
Finland [FIN]	✓	✓	✓
France [FRA]	✓	✓	✓
Germany		✓	
Hungary	✓		
Iceland	✓		
Israel [ISR]	✓	✓	✓
Italy [ITA]	✓	✓	✓
Japan [JPN]	✓	✓	✓
Korea		✓	
Latvia	✓	✓	
Lithuania [LTU]	✓	✓	✓
Luxembourg	✓		
The Netherlands		✓	
New Zealand	✓		
Norway [NOR]	✓	✓	✓
Philippines		✓	
Portugal		✓	
Russian Federation [RUS]	✓	✓	✓
Moscow [RUM]			✓
Singapore [SGP]	✓	✓	✓
Slovak Republic [SVK]	✓	✓	✓
Slovenia [SVN]	✓		✓
South Africa [ZAF]	✓	✓	✓
Spain Catalonia [ECT]		✓	✓
Thailand [THA]	✓	✓	✓
United States		✓	

Notes :
Letter codes used for systems participating in SITES 2006.

Appendix C

Binary logistic regression

Binary logistic regression is a technique for predicting the mean value of a binary response variable as a function of one or more covariates. Logistic regression which models the *probability* of a positive response (e.g. a "yes") is generally adopted in such situations.

If the percentage of ICT-using teachers within a group (e.g. an age group) is μ, this is the proportion of teachers in the group who have answered "yes" to the question on whether ICT was used with the target class. Therefore, in this group, the probability for a teacher to be an ICT-using teacher is also μ, and the probability for a teacher to be not an ICT-using teacher is $(1 - \mu)$. In logistic regression, instead of working with the mean directly, "odds" is used in the computations. Odds are defined as the ratio of the probability of teachers answering "yes" to the probability of teachers answering "no":

$$\text{Odds} = \mu / (1 - \mu)$$

The equation for binary logistic regression is similar to that for ordinary regression analysis, except that the dependent (or predicted) term is the natural log of the odds ratio. Statistical packages such as SPSS provide the odds ratio and the significance of the odds ratio for each independent variable included in the logit model.

The odds ratio for a continuous predictor variable is a multiplicative factor by which the predicted odds change given a 1 unit increase in the predictor variable, holding all other predictor variables constant in the model. Therefore, if the odds is equal to 1, then changes in the predictor value will have not effect on the predicted odds. For example, the level of self-reported pedagogical ICT competence is a continuous variable, and if the odds computed is 1, that means the odds of a teacher using ICT with the target class would not change even if the self-reported ICT competence changes. On the other hand, if the odds ratio is greater than 1, for every increase in the pedagogical ICT competence by 1, the new odds for the teacher using ICT with the target class will be increased by a factor equal to the odds ratio. By the same token, an odds ratio smaller than 1 indicates a decrease by that factor on the odds for every increase in the predictor variable. Agresti (1996) and

Menard (1995) provide a good introduction to binary logistic regression analysis.)

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