Appendix 4.2.2

ICT KNOWLEDGE MANAGEMENT COMPETENCIES – A PLAN FOR SITES-M3

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Key to Acronyms and Special Terms:

COMPED - Computers in Education Study (of IEA)
DPC – Data Processing Center of the IEA
EP - Emerging (Pedagogical Practices) Paradigm
GA - General Assembly of the IEA
ICC - International Coordinating Center
ICT - Information and Communications Technology
IEA - International Association for the Evaluation of Educational Achievement
IPPUT - Innovative Pedagogical Practices Using Technology
ISC - International Steering Committee
International option - ICC-coordinated, but not required research component
KM - Knowledge Management, organizing and utilizing usable information
National option - Research component not required and non coordinated by ICC
OECD - Organization for Economic Co-operation and Development
PIRLS - Progress in International Reading Literacy Study (of IEA)
PISA - Program for International Student Assessment (of OECD)
SITES - Second Information Technology in Education Study
SITES-M1 - Module 1, SITES survey of schools
SITES-M2 - Module 2, SITES case studies of IPPUTs
SITES-M3 - Module 3, SITES proposed surveys and student assessment
TIMSS - Third International Mathematics and Science Study (of IEA)

1. OVERVIEW

Rapidly expanding global networks that support a largely digital economy have accelerated the pace of human change. Perhaps the most dramatic impact can be seen in the redefinition of job requirements to include skills related to using Information and Communication Technology (ICT), especially for the purposes of managing knowledge and knowledge products. ICT knowledge management competencies such as retrieving and organizing information have become central to a huge share of the workforce in many countries. But in many instances these jobs go unfilled due to shortages in ICT-skilled workers. Rapid globalization of ICT has produced unprecedented changes in education as well. In many countries most of the schools are connected to the Internet and many of the teachers have incorporated it into their teaching. Most educational systems offer ways that students can learn to use ICT. Yet in many instances students do not have the ICT-related competencies that would help them learn effectively in school or work efficiently in a job.

SITES, the Second International Technology in Education Study, was initiated by the IEA to investigate such changes in education. The study was approved as a study consisting of three modules:

- Module 1 (SITES-M1) was a 1998 school survey on ICT in learning and teaching;
- Module 2 (SITES-M2) is a set of qualitative case studies of innovative pedagogical practices using ICT; and
- Module 3 (SITES-M3) will consist of a school survey like SITES-M1 with the added value of a teacher survey and a student assessment.

The design of each module has to be approved by the IEA General Assembly at the appropriate time. This proposal presents a plan for SITES-M3 to be approved by the IEA General Assembly of 2000. Each will be summarized briefly.

SITES-M1

In 1998 data was collected using questionnaire surveys of principals and one of technology coordinators or their equivalents. Twenty-six countries participated by conducted these surveys in one or more of these three school levels: primary, lower secondary, and upper secondary. As reported in Pelgrum & Anderson (1999), SITES-M1 produced findings on

- the extent to which ICT is used (and by whom) in education systems across the globe,
- the extent to which education systems have adopted, implemented, and realized the results from objectives that are considered important for education in a knowledge society,
- teaching practices which principals consider to be innovative, important, effective, and satisfying.
- existing differences in ICT-related practices both within and between education systems and what lessons can be learned from this.

Appendix A contains a longer summary of the results of SITES-M1.

SITES-M2

Nearly 30 countries are conducting in-depth case studies during the fourth quarter of 2000 and the early part of 2001. Each case study has to elaborate on Innovative Pedagogical Practices that Use Technology (IPPUT). (See appendix B for more details.). These case studies will provide teachers with examples of 'model' classroom practices and offer policy makers findings regarding the contextual factors that are critical to successful implementation and sustainability of these exemplary teaching practices using ICT. M2 builds on M1, in that it tests the validity of some of the M1 indicators. M2 will help to identify the competencies for the knowledge society by analyzing the requirements of participation in innovative technology-supported pedagogy. Thus findings from M2 will help to guide the design of M3 instruments, particularly those that try to assess these competencies among teachers and students.

Aims of SITES-M3[1]

Module 3 of SITES is intended to address the challenges that education systems currently are facing by measuring ICT knowledge management competencies of students and by investigating the nature of their relationship to student skills, experiences, teaching practices, and contextual factors in the school and home. The results will yield indicators of student, school and teacher readiness to participate in ICT knowledge management and other ICT experiences at home, work, and school. Having such data will improve the ability of policy makers to determine whether or not adjustments need to be made to effectively prepare students for the knowledge society.

SITES-M3 in addressing the challenges mentioned, will build upon the first two modules of the study. SITES-M3 has three main *aims* or *purposes* for this module as follows:

1. *ICT knowledge management competencies*: to determine the extent to which students are able to do ICT knowledge management, including abilities to retrieve and organize information, to integrate and critically evaluate information, to communicate and persuasively present information, etc.

2. *Readiness of schools and teachers*: to determine the extent to which schools and teachers are already practicing new policies, roles and activities characteristic for education meeting the needs of a knowledge society. An important question is whether schools and teachers are already fulfilling the factors that will be identified in SITES-M2 as promoting desired changes in education.

3. *Profiles of ICT in schools including longitudinal developments*: provide profiles of how schools utilize ICT including how the use of ICT in education has developed on certain key indicators since the M1 data collection in 1998. Selected portions of the

[1] The estimate for the SITES M3 study is about HK$ 6.5 that covers the local cost in conducting the study and the international costs, including the international participation fee of US$100K. This estimate is made on the basis of the costs involved in conducting the SITES M1 & M2 studies which included funding for the production of dissemination materials. If dissemination is not included, then the cost would be about HK$ 4.5 to 5 million.

SITES-M1 instruments can be repeated to allow for analysis of trends and factors underlying changes that might be found.

In addressing these aims, SITES-M3 will also look at how other contexts beyond the school, especially the home, serve as environments where students develop ICT related abilities. Country results will be analyzed and interpreted in the context of national policies and practices with respect to ICT in education. This will be an extension of the existing work in progress to produce a compendium or encyclopedia describing the ICT-related policies and practices in over 30 national education systems (Plomp, et. al., 2001).

Design

To address these purposes, SITES-M3 will collect data from students, teachers and schools from three populations, namely elementary, lower secondary and upper secondary education. In each population a random sample of 150 schools will be drawn, and in each of these schools data will be collected from the students of one class, a number of teachers, the principal and the ICT coordinator. Where appropriate and possible, SITES-M3 will apply Web-based delivery of assessment instruments and questionnaires. It is proposed that data will be collected in the 4^{th} quarter of 2003 in the southern hemisphere countries, and in the 2^{nd} quarter of 2004 in the northern hemisphere countries.

This proposal

In the next chapter some characteristics will be given of the emerging 'knowledge society' , followed by a brief discussion of the challenges this puts on educational practitioners and policy makers. The challenge of studying ICT, which is dynamic and changing continuously, is also addressed. Then a *'Student Assessment Framework'* is presented along with a number of operational research questions at the student level. After this comes a *'School and Teacher Assessment Framework'* with operational research questions at school and teacher level. These sections set the stage for the chapter on study design with instrument development, sampling design, data collection procedures, quality monitoring and dissemination. The final chapter will deal with issues related to the further development of the project, such as organization of the study, coordination with NRCs, developmental research tasks, budgets and fund raising, and the selection of the International Coordinating Center (ICC). This proposal ends with a brief discussion of the implications and potential impacts of the study.

2. THE EMERGING KNOWLEDGE SOCIETY

Social analysts around the world acknowledge rapid evolution toward a global, knowledge-oriented economy, and many use the concepts of the “knowledge society” and the "information society" as well as the "global economy," and the "new economy." While they do not agree on projections for the speed of this transition, policy decision-makers in most countries have adopted the rhetoric of the information society and note the inevitability of rapid social change.

For instance, a UNESCO study group on Learning Without Frontiers released a report on Information and Communications Technology (ICT) (Blurton, 1999), as did the World Bank (1998) Consultative Group on International Agricultural Research. Both reports projected major social changes from the global information economy and both recommend special attention to the implications this trend has for developing new mechanisms for life long learning using information technology.

The Group of Eight (G8) meeting in Okinawa, Japan on July 24, 2000 became the first major summit to seriously address the digital divide and related ICT challenges. The very top leaders of France, Italy, Japan, Russia, Canada, Germany, United Kingdom, the United States, and the European Union issued a statement called the "Okinawa Charter on Global Information Society," (http://www.library.utoronto.ca/g7/g20/) which said "We are committed to provide all our citizens with an opportunity to nurture IT literacy and skills through education, lifelong learning and training."

While the rhetoric of the "Information/Knowledge Society" and "life long (or continuous) learning" are sometimes used for marketing purposes, academic treatises also acknowledge the importance of these trends. A balanced view of the profound changes in education from the "Information Society" movement has been offered in a report by Kling and associates in *Learning from Social Informatics* (2000).

The currents of the global knowledge society derive from two major forces, greater inter-cultural interaction and an economic system that treats knowledge as a commodity. Underlying the new role of knowledge in society is, on the one hand an explosion of information and what people think is knowledge, and on the other hand, a greatly increased value for knowledge that help people get what they most want. Figure 1 shows the major implications of the global knowledge economy for the skills and learning strategies of young people, particularly those entering the work force. For instance, making knowledge a commodity means that youth must learn skills in constructing new knowledge such as working on projects.

Figure 1. Implications of the Demands of the Global Knowledge Economy for Youth in Terms of Required Skills and Learning Strategies

DEMANDS from SOCIETY	***REQUIRED SKILLS***	***LEARNING STRATEGIES***
Knowledge as commodity	Knowledge construction	Inquiry, project learning, constructivism
Rapid change, renewal	Adaptability	Learning to re-learn, on-demand learning
Information explosion	Finding, organizing, retrieving	Multi-database browsing exercises
Poorly organized information	Information management	Database construction
Poorly evaluated information	Critical thinking	Evaluation problem solving
Collective knowledge	Teamwork	Collaborative learning

Another characteristic of the knowledge society is a much faster pace of change in what is known and what is institutionalized. The second line in the table notes that young people need to learn adaptation skills and to use on-demand information systems. They can expect that it may be necessary to be highly mobile occupationally, switching among jobs, if not careers. It is no longer possible to keep up with all the knowledge in a field, and employers are more preoccupied with how well a prospective worker is able to learn than how much s/he knows already. The explosion of knowledge implies using systems that require new skills for accessing, organizing, and retrieving knowledge. The knowledge is poorly organized and poorly evaluated, which means that there is a premium on the ability to manage information and critically evaluate it. Furthermore, since knowledge is increasingly collective, it is necessary to learn collaboration skills and to spend more time working in teams.

EDUCATION AND THE KNOWLEDGE SOCIETY

ICT and the rapidly evolving knowledge society pose a difficult challenge to educational administrators and policy makers. Ideological interest groups have formed around different proposals for addressing the future, and each group develops its own rhetoric. Examples include: lifelong learning; distance education; schools as learning organizations; constructivism; student centered learning; high performance learning; and project learning.

Out of this diversity and confusion the first module (M1) of SITES developed a conceptualization called the "*Emerging Pedagogical Practices Paradigm*," which is often abbreviated to "Emerging Paradigm" (EP). It emerged primarily from three intellectual traditions: (1) lifelong learning, emphasizing the need to learn to learn and autonomous learning; (2) constructivism, emphasizing collaborative learning, real-world projects, authentic assessments, and student-responsibility for learning, and (3) information literacy, especially the gathering and analyzing of information.

The Emerging Paradigm (EP) addresses many requirements of the knowledge society but it has not yet explicated the full range of *ICT knowledge management competencies* required. Critical skills like complex, critical thinking, deep understanding, and high performance learning have yet to be integrated into the paradigm. In this regard, our ICT knowledge management focus points to some neglected but critical issues.

It is not accidental that the leading edge thinking about both education and ICT knowledge management tend to focus upon similar issues. Both are attempting to anticipate the future where new forms of ICT are ubiquitous and knowledge is the dominant commodity. The reform rhetorics of education and management demonstrate some striking parallels as Figure 2 demonstrates.

Figure 2. Parallel Directions in Education and Management

Education:	Management
Schools as learning organizations	Organizations as learning systems
Learning to learn	Renewal is integral
Knowledge constructing	Knowledge as product

Collaborative learning and teaching	Knowledge is collective

Similar parallels can be found in the way each institution defines knowledge (Figure 3). The four types of knowledge defined in the first column under Education are adapted from Irwin Anderson's taxonomy (2000) and the categories of knowledge under management were extracted from Allee (1997).

Figure 3. Parallel Definitions of Knowledge in Education and Management

Education:	Management:
Factual knowledge: details, terminology	Data, statistics
Conceptual knowledge: principles, classes, theories	Managing principles, theories, best practices
Procedural knowledge: algorithms, application criteria	Procedural knowledge: rules and specifications
Metacognitive knowledge: strategies, self-monitoring, reflection	Integrative knowledge: strategic plans, philosophies

Scardamalia and Bereiter (1996) have pioneered various strategies linking educational needs with ICT knowledge management concepts. One strategy is to use software that helps students build new knowledge using scientifically guided experimentation and computer-based tools and resources. Another is to foster and guide knowledge-building communities. Learning tools are used that assist both with basic skills and with higher-level knowledge. The common element to these strategies is the goal of preparing learners for the knowledge society through exercises in ICT knowledge management.

Using a somewhat different rhetoric, Jonassen's (1999) "Mindtools" paradigm also seeks to optimize learning using software to augment higher-level ICT knowledge management functions. Mindtools, which are guided activities utilizing software tools, put the student in the role of designer or partner, as most activities require construction of some type of product, usually knowledge. Other activities facilitate collaborative conversations, cognitive amplification, and reflection aimed to enhance critical thinking skills.

These educational approaches also offer guidance in designing assessment strategies for ICT knowledge management skills. For instance, mindtool activities could be tailored for delivery as performance tests in an international assessment.

WHAT IS ICT?

ICT stands for Information and Communication Technology and refers in principle to all technologies used for processing information and communicating. In most educational circles it means computer technology, multimedia and networking, especially the Internet. However educators in the United States and a few other countries use the term “technology" or "information technology" (IT) instead. In business and industry the most common label is IT, but sometimes the terms “new media” or “digital media” are used. This semantic diversity derives from the rapidly evolving integration of computers with communications, video, and audio technologies, where the separate technologies become nearly indistinguishable. In the SITES project we use the acronym ICT but recognize that it means the same as IT or technology to many people.

SITES-M3 also recognizes that the scope of ICT is dynamic and continuously changes with the creation of new technologies. At one time technology referred only to hardware, now it includes software techniques as well. Daily invention of new technologies provides a major challenge to ICT-related educational assessment. To cope with the challenge SITES-M3 will establish a panel of technology experts from both industry and education to project the character of ICT that will be critical to education in 2005, the year that the results of the study will be first released. This mechanism will protect against obsolescence in general and ensure that the assessment domain and instruments reflect changes in requirements for ICT-related knowledge and skills.

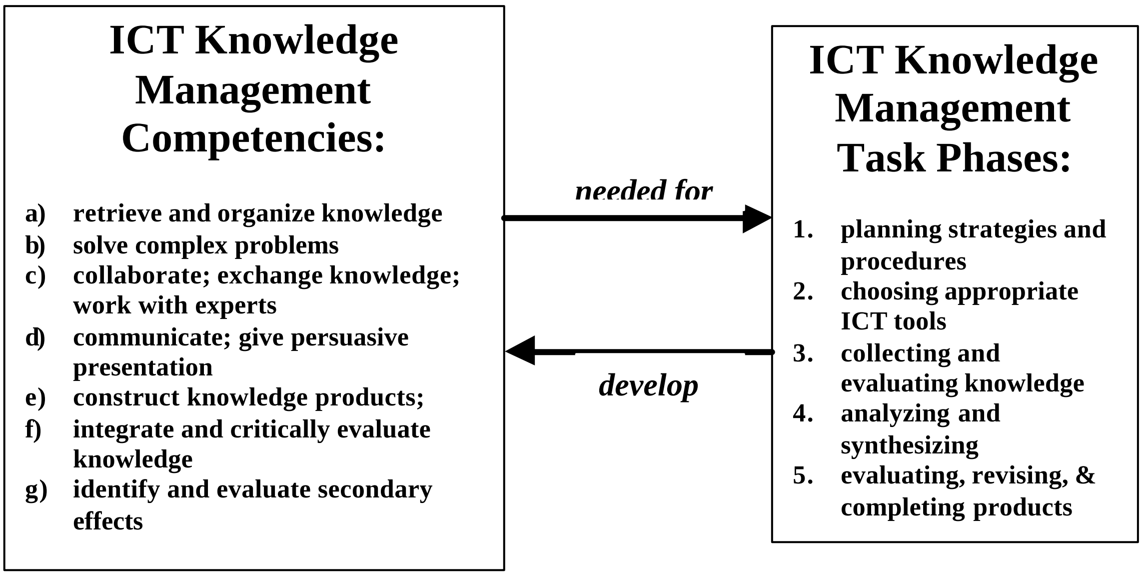
In the year 2000 e-mail is the most common way that young people use ICT, accessing the Internet for regular interaction with friends, family, and associates. However, by 2005 the most popular form of ICT interaction may be wireless mobiles or hand phones with tiny video screens for video conferencing. Other new technologies like Short Message Service (SMS) are rapidly evolving, offering new means of communicating and working. Given the skyrocketing pace of new ICT in the past decade, it would not be surprising in the next five years to see whole new forms of e-commerce like Internet-auctions or radically new ways to do homework using personal software agents that roam the Internet. It is imperative to track such developments because not only do they change the skill requirements for students but they impact society and change research priorities for international research on ICT and education.

3. STUDENT ASSESSMENT FRAMEWORK

In SITES-M3, the term *'ICT knowledge management (KM) competencies* is used rather than *ICT literacy* skills. *ICT literacy* refers mainly to instrumental skills directly related to the use of computers and other technologies such as the Internet. However, in a knowledge society the crucial issue is not having instrumental ICT skills, but skills and abilities to manage knowledge and to deal with information for which in most cases ICT is used. While one may define *ICT Literacy* broadly and including some knowledge management, we use the term *'ICT knowledge management (KM) competencies* throughout this proposal in order emphasize the knowledge management aspect of ICT.

Many publications about education in a knowledge society emphasize that for students to acquire knowledge management (KM) competencies, a student-centered didactical or pedagogical approach is needed (cf. Jonassen, 2000). The student-centered approach advocated by Jonassen is to let students develop or build new knowledge and he suggests putting the student into the role of designer. Both of these approaches illustrate how learning activities that require ICT can result in developing competencies in ICT KM as well as other areas such as self-regulation, creativity, and project management. This learning process can occur from rather well defined learning tasks to more open problem solving tasks aimed at producing 'something'. In the framework of this proposal we identify *'ICT knowledge management task phases'* as the columns of the framework grid (Figure 4). We call these categories ‘ task phases” because to work effectively on KM tasks it is necessary to apply a systematic approach consisting of a number of steps or phases. As illustrated in Figure 4, KM competencies and task phases are mutually supportive. Carrying out KM task phases is only possible by applying KM competencies. Doing KM task phases helps to develop KM competencies.

Figure 4. The Relationship between ICT Knowledge Management Competencies and ICT Knowledge Management Task Processes



These two dimensions structure the content domain for the student assessment. The study will include a third dimension, experiences and attitudes related to ICT, and indicators in this dimension will be contained within the student background survey.

The competencies and task phases of ICT knowledge management define the two dimensions of the table in Figure 5. Each competency can be practiced and utilized in a set of specific, practical tasks that each require multiple task phases. In fact complex tasks tend to require all five of the task phases. A project consists of a collection of tasks or task phases organized to achieve a specific outcome.

Figure 5. ICT Knowledge Management Competencies by ICT Knowledge Management Task Phases*

ICT Knowledge Management Competencies –	*Planning Strategies and Procedures*	*Choosing Appropriate (ICT) Tools*	*Collecting & Evaluating Knowledge*	*Analyzing and Synthesiz-ing*	*Evaluating, Revising, and completing products*
Retrieve and organize knowledge	ÖÖ	ÖÖ	ÖÖ	Ö	Ö
Solve complex problems	ÖÖ	Ö	Ö	Ö	Ö
Collaborate and exchange knowledge; teamwork; work with experts	ÖÖ	ÖÖ	Ö	Ö	ÖÖ
Communicate and give persuasive presentation	Ö	Ö		Ö	ÖÖ
Construct knowledge products including innovations and project completions	Ö	Ö	Ö	ÖÖ	ÖÖ
Int egrate and critically evaluate knowledge	Ö	Ö	ÖÖ	ÖÖ	ÖÖ
Identify and evaluate secondary effects of ICT knowledge management	Ö	Ö	Ö	Ö	ÖÖ

In Figure 5, a double check (ÖÖ) represents that corresponding KM competence is very important to the knowledge management task phase. A single check (Ö) means that the competence is important to the phase. And a blank cell means that the competence is thought to be not important to the process. These judgments of importance were made by the authors and should not be considered ‘absolute’. The importance of the competencies will vary with specific task situations and may change overtime. Next each of the task phases will be described.

TASK PHASES

<u>Planning Strategies and Procedures.</u> Planning is critical to ICT knowledge management tasks, although if the task is routine to the knowledge manager, then the plans may be tacit, that is the planning process may not be done consciously. Planning requires the development or specification of strategies and procedures. Strategies involve larger sets of activities than do procedures and they take into account resources and power or control. For example, the task of deciding whether or not to build a new prison for a region would start with developing strategies for finding historical data on the growth of arrests, convictions, sentences, and prison counts. Statistical procedures would need to be selected for projecting future growth.

Choosing Appropriate (ICT) Tools. ICT is placed in parentheses here because there may be non-ICT tools that are more appropriate for completing the task or project. If this is the case, then it is important that the knowledge worker or student not use ICT tools. The process of selecting tools is highly context driven in that the environment for completing a task may be restricted to a very small set of tool alternatives. A tool-rich context might have a very large number of options, many of which might be needed to complete the task. For the task of projecting the growth of prison populations, the required tools will depend upon whether the various data were available in existing reports or had to be extracted from databases. The extraction from databases would depend upon public accessibility rules, the particular database systems used, and available retrieval tools. Other considerations such as cost and ease of use may come into play. There may be unanticipated problems requiring a change in strategy or change in tools in order to complete the procedures successfully. The tools used may be used in succession or simultaneously and their use may be divided up among team members.

Collecting and Evaluating Knowledge. On the basis of the planning process, knowledge and resources must be found, evaluated and organized. For a decision on building a new prison, not only would statistical data be needed but estimates of building and staffing costs would have to be assembled and reviewed.

Analyzing and Synthesizing. After knowledge or data have been collected, it has to be analyzed in the context of the task or project. In addition to this identification of the detailed aspects of relevant data, it is generally useful to assemble the detail into a holistic summary or synthesis. Such a product may be the main intended outcome of a project.

Evaluating, Revising, and Completing Products. The evaluation and improvement of products or outcomes can have many components in a complex project. In the collection and analysis of data for the decision to build a new prison, each initial type of data extracted will have to be evaluated for accuracy and validity. Comparing data from multiple sources is often an important strategy. In addition to evaluating the quality of the data, the specification of decision alternatives need to be evaluated and refined. For instance, some prison sentences could be shortened or changed to community service. Different sizes and amounts of security of the prison facility could be costed separately with the implications evaluated in detail.

These five ICT knowledge management task phases constitute a model project cycle or sequence. However, in practice these processes will be implemented within many different cycles where earlier processes are repeated after subsequent ones have been started. For instance, after evaluating preliminary reports, it may be necessary to go back to collect more data and/or to select another set of tools. None-the-less, these five processes occur in most ICT knowledge management projects and each process is associated with a somewhat distinct set of behaviors and skills. This means that the categories can be useful in defining a domain of activities for purposes of assessment.

ICT KNOWLEDGE MANAGEMENT COMPETENCIES

This taxonomy of ICT knowledge management competencies was designed to guide the development of an assessment instrument and thus has a relative small number of general categories that encompass the entire array of ICT knowledge management tasks. Each competence category pertains to a set of tasks and should be analyzed with respect to the phases above and the type of knowledge predominating in these tasks. Each competence category requires the use of knowledge from each of the four types of knowledge: facts, principles, procedures and metacognitive, however some require predominantly one type of knowledge.

The ICT knowledge management framework overlaps somewhat with previous attempts to define ICT-relevant skills. *Computer literacy* and *Internet literacy* tend to refer only to basic but minimal skills in using a particular ICT. In 1999 the International Society for Technology in Education (ISTE, 1999) released the "National Educational Technology Standards for Students, and more recently such standards were published for teachers. (ISTE, 2000). Rather than focusing upon specific ICT skills, these standards identified particular tools that students and teachers should be able to use in order to participate effectively in their school work. Some of these tools, e.g., "communication tools," overlap with the ICT knowledge management competencies that we have built into our framework.

A different approach was taken by the National Research Council (1999) of the United States in their report advocating "IT Fluency." *IT fluency* was defined by listing a set of IT skills and supplementing them with a set of concepts and intellectual capabilities that were believed to be needed by everyone to deal with information technology. While their explication was very useful, it focuses more on the concerns of computer science than on ICT knowledge management for students in general education.

Each of the seven types of ICT knowledge management competencies will be described briefly, and in that context some of these alternative approaches to conceptualizing competencies will be discussed.

Retrieve and Organize Knowledge. It is generally recognized that in the age of databases and the Internet the ability to effectively and quickly find and assemble information of all types is critical. Indeed the concept of *Information Literacy*, which was invented about 25 years ago (Spitzer, Eisenberg, and Lowe, 1998), focuses upon this process. The skills required to search and organize information from the Web is what some have called *e-literacy*. While the Web is a great resource, there are numerous other sources of data and knowledge that are needed for many, if not most, knowledge questions. These tools include stand alone and locally networked database systems. Considerable advances are being made in Internet-based systems that integrate browsing capabilities with additional tools that are pedagogically oriented (See Soloway, 2000). Another class of relevant ICT tools is designed to aid in organizing knowledge, and one increasingly popular type is concept mapping. The success of this process seems most dependent upon careful planning of search and analysis strategies, which can not be done effectively until one knows about relevant tools, selects the most appropriate ones, and applies them to carry out the procedures.

Solve Complex Problems. Problem solving has always been a major human challenge, but with new global technologies the problems are more complex and the solutions more critical for producing competitive products. Thus the stakes are higher and the importance of planning strategies and higher-level thinking skills more critical. Not only are complex problems central to school and the workplace but they are relevant to everyday living as well. For instance, selecting a site for a family reunion when family members must arrive from many different locations is a complex problem indeed. Not only is it necessary to collect data on all travel distances and costs to each alternative site, but it is necessary to use planning strategies to select alternative sites. In addition, a model needs to be built to calculate the best solution in order to minimize total costs. In addition, model elaborations may need to be specified in order to take into account individual constraints and special date problems.

Although the ICT knowledge management phases also reflect in principle a systematic problem solving process, we consider it important to list ‘solve complex problems’ also as ICT knowledge management competency. To become skillful in applying ICT KM task phases, it is imperative that students and others possess the generic knowledge and skills on how to design and implement solutions to complex problems.

Collaborate and Exchange Knowledge. *As* already noted ICT offers a large range of communication options and increasingly these are essential for work in teams as well as larger organizations. Sharing knowledge often is an essential aspect of successful teamwork, as is the ability to consult with experts and others located at different levels of the hierarchy. Current ICT options include e-mail, conferencing, and instant messaging, to name a few. Effective communication in most global organizations requires the skills associated with selecting ICT communication tools as appropriate for various types of knowledge work. Inter-cultural communication, both with and without ICT, requires additional skills, which are in high demand. Optimally fulfilling these requirements is critically dependent upon knowing and selecting the appropriate tools. This is especially true as the pace of new communication technology continues.

Communicate and Give Persuasive Presentation. Many knowledge workers are expected to present their knowledge either to report factual data or to persuade an audience to accept particular positions. The use of audio, video, and computing media for such presentations has been called *Multimedia literacy.* Little consensus exists on whether presenters should master multimedia development skills, but most agree that presenters need to understand the media sufficiently to participate in the presentation design process. At the present time both hardware and software technologies are demanding in terms of ICT expertise because the few standards that do exist are rapidly being updated.

Construct Knowledge Products Including Innovations and Project Completions. Knowledge products range from single ideas and tiny documents up to large, completed projects consisting of hundreds of documents and complex models. Particularly at the low end of this continuum, the skilled use of software tools is critical to effective completion. When the targeted knowledge product is large, then all five of the task phases in our framework play critical roles. Depending upon the goal of the task or subtasks, relevant software tools include word processors, spreadsheets, databases, and numerous other application software programs. We distinguish innovation as a type of product because of the importance of innovation and creativity to success in the 21st century.

Integrate and Critically Evaluate Knowledge. This category of ICT knowledge management extends that of retrieving and organizing knowledge. Integration involves evaluation of the quality and relevance of knowledge in order to make appropriate conclusions. Critical evaluation is also called critical thinking and high-performance thinking. A variety of ICT tools, both general and specialized, can be used for these tasks as appropriate. The skills of critical evaluation or critical thinking are included in every recent report on skills required for the 21st century. For instance, the 21st Century Workforce Commission (2000) of the United States defined "21st Century Literacy" as "strong academic, thinking, reasoning, and teamwork skills, and proficiency in using technology."

Identify and Evaluate Secondary Effects of ICT knowledge management. Using ICT knowledge management tools often results in unintended social consequences such as the reduction in personal privacy or an increase in the "digital divide." This knowledge competency encompasses awareness of these secondary effects and the ability to act according to existing legal and ethical boundaries. These actions coincide with *Technological Literacy,* also called *socio-technical literacy*, which has been defined as balancing tool and application potentials with practical constraints, especially social and ethical considerations. New opportunities made possible by rapidly evolving information technology force young users of this technology to confront new opportunities for cheating, plagiarism, access to private, personal information; and access to adult materials. The new global economy depends upon preparing youth to deal with ICT both technically and responsibly.

EXPERIENCES AND ATTITUDES

The student background questionnaire will contain a number of self-report questions asking about amount of experience with a variety of ICT knowledge management tasks and ICT tools, the context for such experiences, and the sources of their skill development. Of particular interest are what ICT skills were developed inside as opposed to outside of school and whether the learning location was related to motivation to learn and quality of learning. In the attitude domain the main focus will be upon the following dimensions or indicators:

- Perceived importance of ICT knowledge management competencies
- Motivation to learn ICT knowledge management competencies in the past and future
- Satisfaction with ICT learning experiences in school (and out of school also)
- Perceived seriousness of ethical issues raised by ICT

These indicators will make it possible to examine the relationship between several attitudinal/motivational aspects and the occurrence of different experiences and skills.

IMPLICATIONS OF FRAMEWORK

While the ICT knowledge management framework may appear to preclude other approaches to defining major ICT skill requirements, it is not as narrow as it may seem. We illustrate this implication by describing some areas of overlap of the knowledge management framework with other approaches, most notably "learning to learn" and informatics. We also discuss the concept of ‘readiness for ICT knowledge management,’ as an operational definition is needed to elaborate the aims of the study.

Learning to Learn. A major tenant of the lifelong learning (also called ‘continuous learning’) movement is that ‘learning to learn” is a critical skill for the 21st century. ICT implicitly supports this by making possible new ways of obtaining “knowledge on demand” or “just in time” learning. There is a large literature on study skills, but contemporary advocates of learning to learn tend to argue that contemporary learning requires much more than study skills. At the present time there is little consensus on how to define and measure the skills of learning to learn. We have not attempted to define a separate ICT knowledge management competency on “learning”, because all of the ICT knowledge management competencies defined above support or contribute to learning to learn. This is especially true of retrieving and organizing knowledge and of integrating and critically evaluating knowledge. In addition, effective *learning to learn* requires attitudes and motivations such as motivation to learn and motivation to take self-responsibility to learn. Even though learning to learn as such is not the main priority for this study, we will assess and analyze some factors central to this phenomena.

Informatics Curricula. Many educational systems have a national informatics curriculum consisting of one or more courses at the elementary and/or secondary level that teach ICT skills. Traditionally, the content of informatics courses has emphasized elementary computer science principles along with some general principles of information management. In many instances students taking informatics also receive hands-on instruction in the use of productivity tools such as word processors, Internet browsers, spreadsheets or databases, and other such technology. Some educational systems offer courses in ICT concepts and applications but do not call it informatics.

While our ICT knowledge management framework is designed to encompass curricula where ICT instruction is integrated into existing courses, it also encompasses the main aspects of the informatics curriculum or its equivalent. A course on the use of productive tools teaches skills in constructing knowledge products such as document production, and retrieving and organizing knowledge with a database system or browser, and solving problems with spreadsheet or other software tools. A curriculum that includes instruction in computer programming typically teaches students these same knowledge management competencies but with different tools. Programming instruction usually puts a major emphasis upon the knowledge management phase that we have called “analyzing and synthesizing.”

Readiness. One of the aims of the study is assess the 'readiness of schools and teachers.' Having introduced the ICT Knowledge Management (KM) framework (Figure 5), we are now in the position to operationalize the concept of readiness to utilize ICT or to do ICT knowledge management. On *student* level, we will define *'readiness'* as competencies such that knowledge management tasks can be performed at an adequate level. In the study we will shorten this to *having ICT readiness*, or *being ICT-ready*. The degree of ICT readiness is then the degree to which students have mastered the ICT KM competencies. We call *teachers ICT-ready* when they can teach students to apply adequately ICT knowledge management competencies in pedagogical tasks. In this study, a *school* is called *ICT-ready* when (1) it has teachers who are ICT-ready, (2) when they encourage and support teachers in working this way, and (3) when they provide learning environments in which students learn to become ICT-ready. The differences in emphasis in these definitions are noteworthy. While the student definition focuses on students mastering of the ICT KM competences listed in Figure 5, the definition for the teachers emphasizes the capability of teachers to help students become ICT-ready, and the school definition specifies the conditions under which students can learn to become ICT-ready.

RESEARCH QUESTIONS – STUDENT LEVEL

It is assumed that assessment instrumentation will allow for comparisons across ICT knowledge management competencies as well as across task phases. Furthermore, it will be possible to make some comparisons across types of instruments, e.g., performance test items versus selection items versus self-report. The questions below, however, address the substantive student-level research questions for the study.

- What percent of students are ICT-ready, i.e., have minimal ICT knowledge management competencies? Or what is the profile of student skills related to ICT knowledge management and how does this differ by educational system, grade level, curriculum, teaching practices, and type of student experience, both in and out of school? Minimal competency levels will be defined in terms of ISTE's (2000) student standards or other emerging benchmarks.
- Does greater exposure to ICT in learning produce greater ICT knowledge management competencies? What types of experiences, either in or out of school, yield the greatest impact?
- What other roles do school ICT experiences have on students' ICT knowledge management competencies independent of home and work experiences? That is, what is the added value that schools provide students with respect to ICT and knowledge management?
- What experiences, including use of home possessions such as books and ICT, do students have and to what extent are they related to ICT knowledge management competencies?
- To what extent are students of different types using the Web (and other ICTs) for each of the following purposes: email related to learning, searches related to learning, projects such as electronic field trips, consulting with experts, building Web sites, and other school matters?
- To what extent are students of different types aware of ethical and legal issues of ICT utilization including copyright violations and privacy violations?
- To what extent are different groups of students (as defined by culture, race, wealth, gender, ability and disability) separated by the digital divide in terms of access to and exposure to ICT as well as skills to use it?

4. TEACHER AND SCHOOL FRAMEWORK

One of the aims of SITES-M3 is to assess the readiness of schools and teachers for embarking on education for the knowledge society. This implies that SITES-M3 seeks to determine the extent to which teachers can teach students to apply ICT knowledge management competencies; whether schools are encouraging and supporting teachers in working this way; and the extent to which schools provide learning environments in which students learn to become ICT-ready. In other words, SITES-M3 will investigate what types of teachers and schools are practicing policies, roles and activities that are meeting the needs of a knowledge society.

It is expected that SITES-M2 will identify a number of factors promoting or inhibiting desired changes in education. The conceptual model underlying SITES-M2 is given in the prospectus in Appendix B. It shows that *innovative pedagogical practices utilizing ICT* (called *IPPUT*s) reflect the interaction of four elements: the teacher, the student, the curriculum content and goals, and the instructional materials and infrastructure (including ICT). The innovative practices of IPPUTs are operational on the micro level of the teacher in the classroom. But they are embedded in the school organization and local community (meso level), which at their turn are embedded in the state and/or national level (macro level).

Intended and actual school policies and practices are influenced by a number of forces or factors:

- Community, state and/or national *policies and expectations* may set goals and/or boundaries for the innovative character of the curriculum and the ICT infrastructure. For example, innovative state or national curricula in combination with active stimulation policies on ICT in education and strong support of parents ('community') are expected to make a difference in the use of ICT.
- *School leadership* can make choices related to the school's curriculum, ICT infrastructure, pedagogical orientation including innovativeness, and staff development of ICT knowledge and pedagogical skills. For example, a rich ICT infrastructure in combination with 'traditional' pedagogical beliefs and a staff development focusing just on instrumental use of ICT will most probably <u>not</u> result in an innovative pedagogy utilizing ICT, but in traditional teaching that may under-utilize the ICT infrastructure
- *Teachers*, both individuals or as groups may influence the role of ICT in schools. For example, many case studies have documented how highly motivated teachers become 'champions' of innovative pedagogy using ICT; conversely lack of enthusiasm tends to result in a 'meager' or minimal use of ICT.

The examples illustrate that choices of key decision makers and other stakeholders with respect to the use of ICT and to the organization of teaching and learning can greatly shape the degree to which the school is ICT-ready. These examples also illustrate how the conceptual framework for the school and teacher level component of SITES-M3 makes use of the traditional IEA distinction between the intended and implemented curriculum and school policies. Figure 6 [2] shows the structure of this conceptual framework for the school and teacher surveys of SITES-M3.

The research questions for this part of the study are divided in four groups:

[2] In developing this framework, use has been made of he conceptual frame for SITES-M2 and of frameworks developed by Nancy Law (Hong Kong), and Alfons ten Brummelhuis (the Netherlands), and Karen Seashore Louis (United States).

(1) Curriculum: intended, implemented and attained curriculum with a special emphasis on innovative pedagogy and the existence of IPPUTs;
(2) School: policies, pedagogical climate, (ICT) infrastructure, parents contribution;
(3) School leadership: the extent to which there is vision and/or innovativeness in taking steps to initiate and maintain an environment conducive to learning and using KM.
(4) Teachers: their ICT KM competencies; their use of ICT, their attitude towards innovation and ICT, etc.

For each of the four groups, a number of research questions will be presented. The first NRC meeting will review these and draw up the final list. However, it is assumed that the research questions mentioned in this proposal will become the core of this part of SITES-M3.

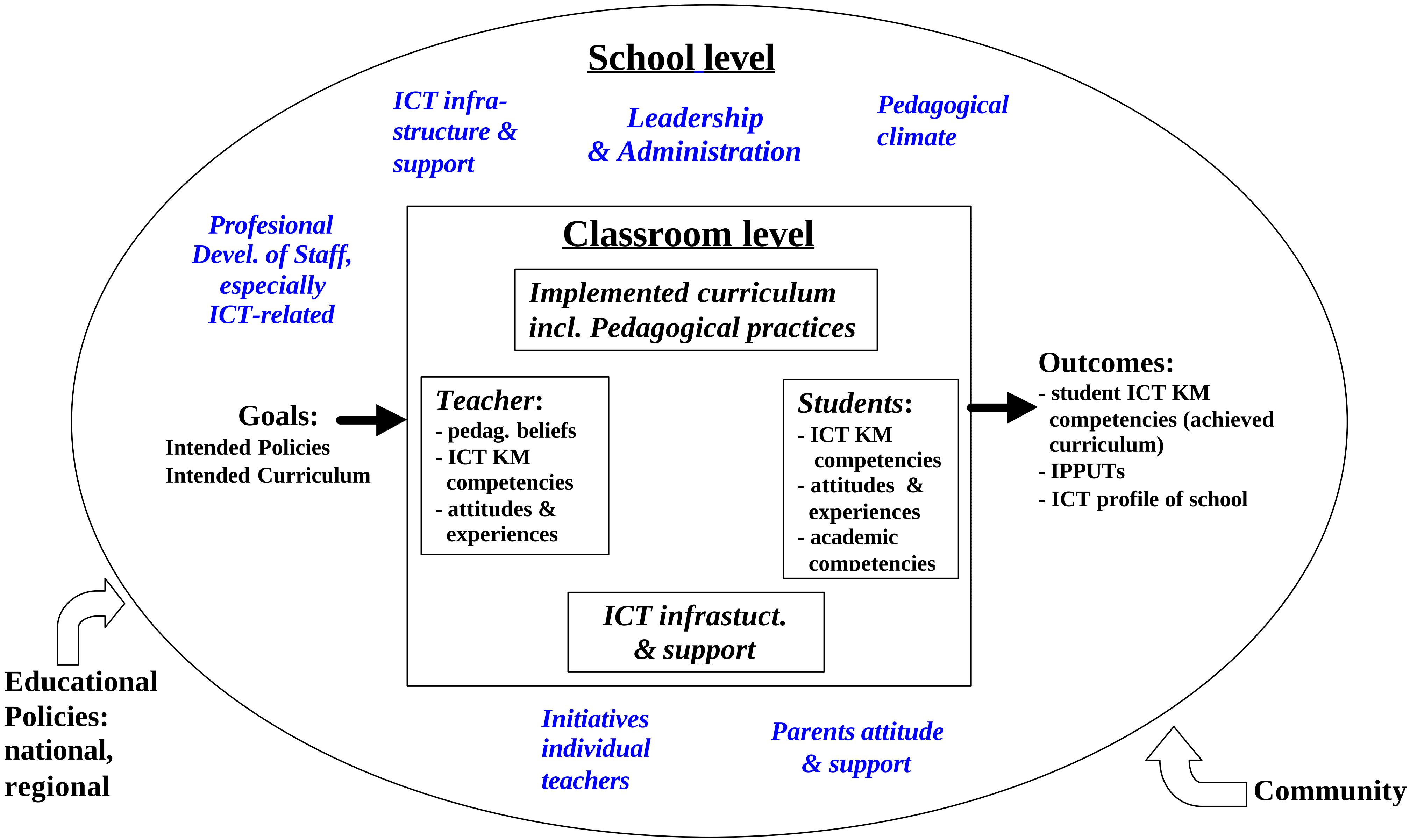
RESEARCH QUESTIONS – SCHOOL AND TEACHER LEVELS

In SITES-M3 all elements in Figure 6 will be operationalized in the instruments to the respective target groups, addressing both aims: (1) to what degree do schools and teachers demonstrate ICT readiness, and (2) what are the changes with respect to 1998, the year of SITES-M1 data collection. The components in the framework that refer to students are dealt with in the section on student assessment.

<u>Curriculum</u>

- What is the intended curriculum with respect to ICT knowledge management and ICT skills and at what level of detail is it proscribed? For some countries this can be described at a national level, but this can be assessed at the school level as well.

Figure 6: Conceptual framework schools and teachers survey



- What is the implemented curriculum (pedagogical practices pertaining to ICT knowledge management) as described by the teachers? How does this correspond to the intended curriculum and the attained curriculum as measured by the student assessment?

Schools

- What are the ICT school profiles and how do they differ by system and type of school? For instance, what is the ICT infrastructure as measured by ICT density, local networking, Internet accessibility, and software availability and how does it vary across systems and by type of school?
- How does this infrastructure correspond to utilization of the infrastructure as measured by variety and types of student and teacher participation in ICT knowledge management activities including global network participation?
- How have school indicators related to ICT changed since 1998 and what appear to be the main influences upon this longitudinal process?
- What school factors are associated with greater utilization of the ICT infrastructure?

School Leadership

- What is the role of ICT knowledge management in the teacher professional development program? How much has this changed since 1998?
- What policies does the school have in place with regard to ICT curriculum, staff development, and use? What other policies have been established to stimulate the integration of ICT?
- What are the perceived obstacles to ICT integration? What factors condition these perceptions?
- To what extent is ICT used in school management and how is this related to the ICT infrastructure for instruction?
- To what extent does the school offer support services for teachers' use of ICT and innovative pedagogical practices (IPPUTs)? What school characteristics are these associated with?
- What are the beliefs and goals of the school leaders regarding ICT knowledge management and how does this relate to practices within the school with respect to ICT integration and ICT knowledge management practices in the classroom?

Teachers

- To what extent do teachers use ICT knowledge management practices for various purposes both in and out of school? How does this differ by characteristics of the system, the school, and the teacher?
- What needs pertaining to ICT knowledge management do teachers perceive and what school characteristics are they associated with?
- How do teachers view the students' skills with respect to ICT and how does that correspond to the measured skills of the students?
- What are the teachers' experience and skill related to ICT knowledge management and how does this differ by school context and teacher characteristics?
- Do schools with greater emphasis on ICT knowledge management tend to have teachers that are more likely to report having greater ICT knowledge management skills?
- To what extent do teachers perceive their role with ICT as professional? How does affect their participation in ICT knowledge management pedagogy?

KNOWLEDGE MANAGEMENT PEDAGOGIES

To guide the development of instruments to assess students KM competencies (see Figures 4 and 5), it is important to have an understanding of what types of instructional practices could be applied resulting in these competencies. The taxonomy of knowledge management (KM) pedagogies, discussed in this section, was designed to guide the development of survey research on teaching practices in SITES-M3. The categories used are not expected to be the final ones used in the study nor are they considered static. This categorization of KM pedagogical practices draws upon a variety of sources including reports from the National Research Council (1999a and 1999b), Newmann and Associates (1996) work on *authentic achievement*, the *Teaching, Learning and Computing* project' s findings on the use of ICT in constructivist pedagogy (www.crito.uci.edu/TLC), and the *'Emerging Pedagogical Practices"* framework from M1 and M2 of SITES (Pelgrum and Anderson, 1999). Each of the knowledge management pedagogical practice categories will be described briefly.

Projects with Student Choice & Independence. Many different types of projects can be assigned to students that give them some choice in selecting topics, solution strategies, and communication vehicles. A major value of such projects is the opportunity for students to learn self-direction and responsibility for their own progress. An increasingly popular form of project learning is the assignment to use ICT to retrieve, organize, and evaluate the quality of information found. Assuming that the assignment is relatively unstructured, it has the potential to help some students learn to make their own decisions in addressing knowledge tasks. This pedagogy

Practice in Higher Order, Critical Thinking. If students are challenged to use complex thinking skills like combining ideas and information in an attempt to discover new meanings and understandings, then we can say that they are performing *higher order thinking*. The opposite kind of thinking simply uses repetitive processes to accumulate facts or to apply simply rules. Teachers can implement this type of pedagogy either by engaging students in classroom discourse or in completing assignments. Newmann, Secada, and Wehlage (1995) offer a definition and rubric for determining the degree to which classroom instruction is engaging students in higher order thinking. Furthermore, their research has demonstrated that students exposed to such pedagogy tend to experience gains in achievement on standardized tests.

Teamwork and Other Collaboration. As already note in the discussion of the knowledge society, there is general consensus that knowledge management often requires collaboration and teamwork. Not only does a knowledge product often depend upon the ideas or contributions of other people, but success often depends upon highly interactive problem solving on joint projects. Assigning school work that requires teamwork or more distance collaboration can help students learn these skills, with and without the assistance of electronic communication. In fact one of the advantages of this pedagogy is that students can learn when it is most appropriate and productive to use different modes of ICT-based communication. Additional types of learning may accrue such as acquiring appreciation of diversity in individual contributions and learning the importance of giving social support and maintaining community in the process of collaboration.

Practice in Diverse Presentations and Discourse. Newmann and associates (1995; 1996) have conducted research on pedagogies that incorporate classroom discourse devoted to creating or negotiating shared understandings of subject matter and have found that it is associated with achievement gains. While they emphasized the "sustained conversation" aspect of discourse, there are other diverse forms of visual and auditory communication. Learning to use and to present ideas with multiple representations, both with and without ICT, is a major outcome of this pedagogical practice.

Assignments to Construct Knowledge Products. The first category of KM pedagogy overlaps with this one. But the former category emphasized projects as a basis for learning independence and decision-making. This pedagogy emphasizes construction and completion of knowledge products that do not necessarily give students choice of the tasks and resources. Assignments that require the student to construct things like stories, a work of art, or a chart, give students practice in developing their creativity and in assembling knowledge into new structures.

Practice in Searching, Organizing and Evaluating Knowledge. This pedagogy also lends itself to *project learning*. Exercises in searching, organizing or evaluating a knowledge base can directly build student ICT knowledge management competencies. Research is currently underway in how best to use the Internet pedagogically to develop these skills (Soloway, et. al. 2000).

Practice in Self-assessment including Secondary Effects. An important metacognitive activity involves self-monitoring and reflection. Exercises in reflection at different stages of a task process can yield important learning payoff. The National Research Council' s (1999) review of research on how people learn concluded that metacognitive activities involving reflection were a critical method for fostering learning. In this category we have linked self-reflection with analyzing possible second order or third order consequences might result from taking a specific action. Significantly this type of reasoning and reflection include developing awareness of the effects of selecting specific knowledge management steps, especially those involving ICT.

Figure 7. ICT Knowledge Management Competencies by Knowledge Management Pedagogies*

ICT Knowledge Management Competencies —	*Projects with student choice, inde-pendence*	*Practice in critical, higher-order thinking*	*Teamwork and other collab-oration*	*Practice in Diverse Present-ations and discourse*	*Assign-ments to construct know-ledge products*	*Practice in searching, organizing and evaluating knowledge*	*Practice in self-assess-ment including 2ndary effects*
Retrieve and organize knowledge	Ö					Ö	
Solve complex problems		Ö					
Collaborate and exchange knowledge; teamwork; work with experts			Ö				
Communicate and Give Persuasive Presentation				Ö			
Construct knowledge products including innovations and project completions					Ö		
Integrate and critically evaluate knowledge						Ö	
Identify and evaluate secondary effects of ICT knowledge management							Ö

Symbol key: A check indicates major impact of the pedagogy upon student competencies.

5. STUDY DESIGN

This section contains some details of the data collection, sampling, and dissemination plans. First a proposed plan for a curriculum analysis is discussed.

CURRICULUM ANALYSIS

IEA studies with a clear subject matter orientation, like TIMSS, have a curriculum analysis as a basis for determining what topics should be included in the student assessment and also the relative weights for each of these topics. The problem with curriculum analysis of ICT is that in many countries it is not a discipline at the school level (like mathematics or science). In some countries the schools do not even offer a course in ICT or informatics. On the other hand, most countries in SITES-M3 will offer some instruction in ICT related skills or ICT knowledge management competences. In order to develop student assessment instruments that reflect the various ways countries address the teaching of ICT, it is necessary to conduct some type of curriculum analysis. This will be done by conducting the following activities:

- *document analysis*: It is expected that countries who do teach a course in informatics or ICT do have documents describing the intended curriculum. These can be formal statements on national or state level describing attainment targets and/or even a syllabus for this area. Other countries may have documents explicating how ICT should be dealt with in existing courses and/or indicating what ICT competences students are expected to acquire during their school education leaving it up to the schools to give it a place in the curriculum. In some countries, where education is decentralized, there may exist a variety of curriculum documents each valid for a region, state or province. All countries will be asked to collect relevant documents. A framework (based on the ICT KM framework in Figure 5) will be developed for analyzing these documents and reporting the results to the ICC.

- *chapters on national policy on ICT in education:* Within the framework of the SITES study, each NRC participating in M2 (and a few other countries) is in the process of writing a chapter on 'national policies and practices on ICT in education'. It is expected that the editing of these chapters will be finished by the end of 2000 and that a book will be published in 2001. Within the SITES study, these chapters will also be available on the Web. The NRC's of the countries participating in SITES-M3 will be asked to provide an update of these chapters reflecting the situation in 2002 with a special emphasis on the curriculum aspects.

- *expert judgments:* As it can be expected that the diversity within and between countries will be large, expert judgments will be used in each participating country to determine the relative importance for that country of the cells in the ICT knowledge management framework presented in Figure 5. After the framework will have been discussed and approved by the participants in an early stage of the study (on the basis of a review of an international panel of experts), operational definitions of each of the cells of the framework will be developed. On the basis of these descriptions, in each participating country a panel of experts on ICT in education and experts on ICT practices in schools will judge for each population the relative importance of each cell for their country. These judgments need to indicate for each cell or topic the 'relative importance' for all, a part or none of the students in the population. For example, importance could be scored on a 3-point scale 'very important, important, not important', while the number of students for an importance score can be indicated as all (≥ 90%), most (50 - 90%), a substantial number (20-50%), a small number (up to 20%), or no students.

A procedure needs to be worked out to determine the relative weight with which each of the cells will be represented in the SITES-M3 competencies test. Note that some ICT curriculum content, e.g., programming, may be outside the scope of the grid. In which case such a topic might become a national or an international option if there are some countries that wish to assess it.

ASSESSMENT

Four types or modes of assessment will be used: self-report questions; selection items such as multiple choice; performance tasks; and other constructed response exercises. Constructed response items are open-ended but may require only a single answer as in a typical mathematical problem. For such items students will be asked to supply intermediate work in order to analyze how the answer was derived and the source of an incorrect answer.

Tentatively we will limit the size of the instruments so that both the assessment and the background questionnaire can be administered within a two-period block of time, that is, about 90 to 100 minutes. A matrix sampling of item blocks may have to be used in order to ensure broad coverage of items across the assessment framework.

Performance assessment

There are a number of performance testing formats that will be considered in developing this aspect of the study. Alternative formats range from selection items associated with a vignette, up to entire portfolios containing multiple projects. For this project the most attractive formats appear to be in between these two extremes. One is the presentation of a vignette followed by constructed response questions asking for a short answer or a short essay. Another is the required completion of a project according to guidelines specified. Answers to both of these formats can be scored according to either holistic or structured rubrics. The knowledge base that the student has to work with can be limited to a single source like a specialized server or can be defined broadly from the Web.

INSTRUMENTATION

In order to test the research questions in previous sections, in addition to a student assessment and a school survey, it will be necessary to plan a new teacher survey. The school survey will consist, as it did in 1998 for M1, of two questionnaires, one to be completed by the principal and the other by the ICT coordinator or an equivalent. The specific instruments required for the design are listed in Figure 8. Each instrument must be prepared for each population. However the manuals containing the common instruments for all the countries can in most cases be combined for all three populations. The codebooks will have to be produced separately for each population.

Alternative modes or delivery mechanisms for the survey and assessment instruments are of major interest to the project and will be built into the final design. While standard paper-and-pencil forms of the survey instruments will be provided, electronic response options also will be provided. While diskette or CD-ROM mailers might be offered, the main alternative response mode will be a Web site questionnaire delivery. In this mode Web-served applets would administer the questionnaire to the respondent and collect the responses into a database. The key to avoiding bias due to electronic modes of questionnaire administration is to make the Web-delivered questionnaire as isomorphic or similar to the paper version as possible. With such an option available, considerable improvement in response rates should be possible. The costs of Web delivery of questionnaires in many different languages are expected to be relatively low, as the delivery software does not have to be re-developed for each language.

Figure 8. Instruments and Manuals Required

	Population 1	Population 2	Population 3	Combined
Instruments				
Principal Quest.	x	x	x	
Tech. Quest.	x	x	x	
Teacher Quest.	x	x	x	
Student Quest.	x	x	x	
Student Test	x	x	x	
Performance Test	x	x	x	
Manuals				
Curriculum Analysis				x
Sampling				x
Administration+				x
Data Entry & Coding*	x	x	x	
Codebook	x	x	x	

+Includes both performance and regular assessments
*Data Entry and Coding Manual includes cleaning as well as entry and coding. It also includes scoring for assessment items.

SAMPLING

In each country after schools have been randomly sampled, a random selection of teachers for the teacher survey will be made and a random selection of a single classroom will be made for purposes of the student assessment. All of the students in the selected class will be administered the student assessment and the student background questionnaire.

Population Definitions. For purposes of assessment, a single grade will be selected from each of the three main grade levels: primary, lower secondary and upper secondary. These three grade levels are called populations 1, 2, and 3, because they will not necessarily be the same grades in each country due to differences across education systems, especially in the age that the students first start school. However, based upon M1 the most common target grades probably will be grades 5, 8 and 12, as M3 will use essentially the same definitions and criteria for populations and grade selection as were used in M1.

In SITES-M1 the following population definitions were developed to achieve integrity in the sampling design between M1 and M3. A second objective was to provide for limited comparability with other IEA and OECD studies. Population 1 was defined as the grade with the most students at age 10 in the eighth month of the school year. (The eighth month was chosen as a fixed date close to the likely month of testing in M3.) Population 2 was defined similarly except that the target age was 14 instead of 10 years. Population 3 was defined as the last year of secondary school.

A *target grade range* was also defined for purposes of comparing school resources across educational systems where the grade groupings vary greatly by country. The concept of "*target grade range*" was needed for asking questions about the accessible infrastructure and common experiences of students in a meaningful but comparable grade grouping. The definition of target grade range was especially significant because not only were many questions worded so as to refer to these target grades, but the number of students in the grade range was used as the measure of size (MOS) for purposes of sampling and weighting. The target grade range was defined as the three grades containing the most students of age 10 and 14 respectively for populations 1 and 2. Thus the target grade would generally, but not always, be the middle of each of these three grades.

The biggest technical difficulty with the target grade range specification was that in some systems a school level boundary fell somewhere within the grade range. The guideline for such situations was to take the school level with the two grades with the most age-eligible students and to define those two grades as the target grade range. In such situations the National Research Coordinator (NRC) worked with the International Coordinator and the Sampling Coordinator to select the most appropriate but comparable grade range.

For population 3 the target grade range was the last two grades of secondary school. From our M1 experience we know that the definition of population 3 will continue to be a challenge. The issues encountered were (i) whether vocational education should be included; (ii) within vocational education, whether apprenticeships involving primarily out of school work experience should be included; (iii) how to deal with school leavers some of whom might be continuing in education at another school; (iv) within a school, how to deal with classes of which a proportion - perhaps a majority - would be leaving school, but for whom the remainder would be remaining in school. As the best resolution to these issues will depend upon the distribution of school leavers within and across educational systems at the time of the assessment, the ICC will survey NRCs early in the project to determine the characteristics of this distribution. The ICC in association with interested NRCs will finalize a definition of the target grade range for population 3 and guidelines for determining how exceptions should be handled.

Population Coverage. With respect to population coverage a definition similar to that of SITES-M1 is likely to be used. Specifically, countries could define a population that excluded a small percentage (less than 10%) of certain schools or students that would be very difficult or resource intensive to test. For example, schools for students with special needs or schools that were very small or located in extremely remote areas might be eligible for exclusion.

The SITES-M1 report included all countries in its tables, even if the country' s survey did not meet the international guidelines for sampling. Those that did not meet the guideline were flagged or asterisked. In M3 several different levels of noncompliance will be explicitly defined, from more serious to less serious, and these categories will be represented as sections "below the line" in each table reported, much those in the TIMSS reports. Tentatively the sections below the line will be defined separately for those systems not meeting the specifications for (1) representative sampling at the school level, (2) school sample participation rates, (3) classroom sample procedures or participation rates.

Probability Sampling of Schools. In each country the realized sample will be a minimum of 150 randomly selected schools per population. Schools are to be selected at random in proportion to the size of the student population in each school. Participating countries will not be required to collect data for all three populations. However, one of the populations, e.g., population 2, may be defined as required so that there exists a common basis for comparing all systems participating in the study. With help from the NRCs, a decision will be made on this early in the project.

In accord with IEA technical standards, a minimally acceptable school response rate will be established for various sampling conditions, e.g., with or without replacement. Tentatively the minimum acceptable response rate will be 65% without replacement and 80% with replacement. For systems carrying out a complete enumeration, the response rate must be at least 65 %. These minimum thresholds are slightly lower than those of TIMSS and SITES-M1. We feel that that lower standards are justified because of several factors. One is that it is increasingly difficult to get schools to participate, due to increased demands from other research projects and increased demands for school performance. Secondly, the precision of measurement of student performance is less critical for ICT than it is for core subjects like math and science with long histories of examinations and assessments. Thirdly, and most significantly, the cost of obtaining high response rates has risen greatly in the last few years. Even with a combination of many e-mail, telephone, and mail pleas to respond, school administrators and teachers are less and less willing to participate in research studies, particularly those like international studies that have no direct contribution to their local accountability requirements.

Sampling Teachers and Students. Each school that is willing to participate, will be asked to provide a list of teachers for participating grade levels and a list of classes for purposes of sampling students. From the list of target-grade teachers a sample of 15 teachers will be randomly selected for participation in the teacher survey. (A minimally acceptable percentage of responding teachers will be established later, but it will probably correspond to the minimum school participation rate.) For those schools with less than 15 teachers in the target grade, every teacher will be asked to complete the survey.

The justification for attempting to acquire up to 15 teachers per school is that on the average at least 10 teachers per school are needed for multi-level analysis of teachers within schools. Also, to measure the potential impact of teacher climate and pedagogical orientation on students, a sizable sample of teachers within each school is necessary. Without multilevel analysis we cannot attribute differences in student performance and experiences to teaching practices. And without such analyses we can not determine if the reason that students appear to be learning anything pertaining to ICT in school, rather than at home, has anything to do with teacher-related variables such as the teachers' expertise, staff development experience, or pedagogical orientation..

For purposes of selecting a classroom of students for the assessment, the school will be asked to identify an intact course that is required of all students in the target grade. After obtaining the list of classes of this course, one of the classes will be randomly sampled. The intention is to give every student in the target grade an equal chance to be selected for the assessment.

In the many systems that do not have an informatics curriculum but have a policy to infuse ICT instruction across the curriculum, it is not likely that the teacher of the sampled class will have significant influences upon the students' experiences and expertise in ICT. However, in systems that have an ICT or informatics curriculum, the teacher's role in student learning is likely to be substantial. Thus we propose that there be an international option that includes an extensive questionnaire survey of the teacher of the intact ICT class.

If it appears that logistically it will be impossible to provide a hands-on performance testing environment within the school for all students in the selected class, then a sampling procedure will be necessary. This will be developed at a later point in time when the availability of resources for performance testing can be estimated more effectively.

QUALITY MONITORING

In order to ensure the highest possible quality control within realistic financial constraints, we propose to establish a new structure of quality monitoring. A critical element in this structure will be a consultant hired to be a Data Quality Monitor. This role would be similar to that of the Sampling Referee in that the Data Quality Monitor would adjudicate the agreement between each NRC and the ICC and the DPC regarding the collection and processing of data. The person selected for the Data Quality Monitor role would not be a member of the ICC but could be a member of the ISC, which would substantially save on travel costs to meetings.

Secondly, we propose that within each country the NRC appoint an Assessment Monitor. This person should not be a member of the NRC's staff but could be a member of the National Steering Committee. The Assessment Monitor would be expected to observe the assessment procedure in a random sample of schools during the administration of the assessment. Thus the role of the Assessment Monitor would be similar to that of the Quality Monitor of TIMSS but the preparation and cost would be substantially less. Regional workshops may be offered to train the National Assessment Monitors.

The National Assessment Monitor could also serve as the Translation Judge to arbitrate among differences of opinion regarding best translations of elements of the instruments and manuals. While the translation procedures for this study have not been detailed, we tentatively propose that the procedure be to get for each language two independent translations from English to the local language. A Translation Judge would be responsible for seeking advice on translation issues from local experts and from the ICC, as well as to make the final decision on translation issues.

Other types of quality control procedures will be coordinated by the ICC with the help of the DPC. Each product that NRCs deliver will be reviewed for accuracy and consistency.

ANALYSIS

The analytical methods used will be guided substantively by the research questions listed in prior sections and technically by quality of the data. In the early phase of the project, the ICC will prepare an “Analysis Plan” which will include a proposal for the selection of indicators to use in developing school ICT profiles, a proposal for indicators to use in longitudinal analysis, and dummy tables or other specifications for statistical analysis.

Before the substantive analysis begins, measurement analysis will be applied to the data in order to determine if the constructs were validated by the indicators, and if so, to what degree. To determine the quality of the assessment instruments, item response theory (IRT) analysis will be performed for each country and each population. Differential item functioning (DIF) analysis will also be applied to determine if particular items functioned differently and hence might have produced an unintended bias for a particular type of student. Concurrently with the scaling and validity tests, will be the calculation of sampling errors. Sampling errors estimates will take into account the complex sample design used by each country by using appropriate programs like WESTVAR.

To as great an extent as possible, the data will be analyzed so as to take into account the hierarchical structure in the data. HLM methods will be used as appropriate to test for relationships across multiple levels of the structure. This will make it possible to explore whether or not school contexts have an effect on teaching practices and orientations, and also, to determine to what extent school contexts and teaching practices shape student competencies, experiences, and attitudes. Of special interest is the relationship between ICT Knowledge Management competencies of the students and the ICT Knowledge Management Pedagogies of the teachers.

DISSEMINATION

An ICT study will necessarily rely upon extensively upon electronic dissemination of results in the form of news releases, reports, and data. Considerable effort will be invested in designing a Web site that is easy to use and effective for finding answers to questions from practitioners and policy makers. Like the Web site for M2 (http://sitesm2.org), the M3 Web site will contain password-protected areas for internal communication among NRCs and members of the ICC and ISC.

The written reports will be downloadable and orderable in print form. The main reports will be similar to those of TIMSS with one report for each population: “ICT and the Upper Secondary Years,” “ICT and the Middle School Years,” and “ICT and the Primary School Years.” The COMPED project and the SITES-M1 survey reported all three populations in a single volume, however the tables were cumbersome to read and implicitly emphasized population or grade level differences more than was warranted. Population or grade-level comparisons are important for some purposes, so we propose to include a chapter in each report that gives the results for all three levels for selected, key indicators such as students per computer, percent of schools with Internet access, percent of teachers using ICT in the classroom, and overall student performance in ICT Knowledge Management.

The structure of each main report will follow the TIMSS' s reports except that less emphasis will be placed upon separate content area comparisons, and in addition a chapter will be included on school level results using indicators from the principal and the technology coordinator questionnaires. This school level chapter will contain comparisons with M1 results on major indicators of interest.

In addition to the main reports there will be a separate technical report giving details on sampling, quality control, data collection, and statistical procedures. This technical report will contain instructions for researchers interested in using the released (public) data files from the study. The study will follow the conventional practice of releasing 50% of the items. Finally, a separate report is expected on details of the performance assessment.

6. STUDY DEVELOPMENT

DEVELOPMENTAL PROJECTS

There are several research projects that should be conducted as part of the study development because of the pioneering nature of the study. Such development projects should address the following methodological questions:

a) To what extent is it possible to conduct a *curriculum analysis* of ICT in K-12 education? How can the ICT-related curricula of decentralized systems like USA and UK education be characterized when there are so many variations in regional policies and so many proposed approaches to developing ICT-related knowledge management competencies? A pilot study could apply several models for summarizing the curricular information in two or three diverse countries. This would make it possible to determine the feasibility of several approaches to obtaining and structuring appropriate information.

b) To what extent are student and teacher *self-reports* of ICT knowledge management competencies valid? For which topics and which formats are the responses most accurate? ETS has done some validity studies of their computer familiarity self-report measures. These measures could be updated and extended and then used in a small-scale validation study where the self-reports are compared with corresponding test items. It would be desirable to include both performance and paper-and-pencil items in such a validation study.

c) For *Web delivery of questionnaires* and performance items in an international comparative study, what are the constraints that may be required in terms of character sets, keyboards, Web interfaces, etc.? Since we are proposing to include Web delivery as an option for respondents who prefer such a response mode, some pre-pilot studies are needed to determine: the best technical configurations and methodologies; the receptivity of typical respondents to this media; and potential effects on response rates and response bias. The pre-pilots should be done in two or three countries before attempting to transfer the technology to a larger number of countries.

d) For *Performance Testing*, what are the measurement consequences of using different approaches to the specification of performance test items using the Web and Wed-based information delivery? For performance testing of ICT knowledge management items, what would be the optimal solution for the trade-off between authentic item sets and totally independent item responses? (Typically authentic item sets are inter-dependent and hence not statistically independent for testing purposes.) This development project will require the adaptation and construction of performance tests appropriate to ICT KM competency testing. Concurrently with this development, small-scale studies should be started to test these research questions and to determine an optimal set of performance test items.

e) How can the study be designed to *include physically and cognitively challenged students* in the assessments and surveys? In the past students with disabilities have generally been excluded from international assessments. Now there are numerous 'assistive technologies' in the form of hardware and software that makes it possible for many more challenged students to participate in school work and take tests. Some investigations are needed (1) to assess to what extent the information is available cross-nationally on school policies for inclusion and exclusion, (2) to what extent assistive technologies are being used in schools, and (3) to what extent these assistive technologies could be incorporated into the SITES-M3 assessment procedures, especially for those students with access to them. Depending upon the answers to these questions, we may find it possible to conduct a sub-study that determines to what extent assistive technology is used to enable students to participate in schooling and to achieve better results.

In addition to these research tasks, there will be the extensive development of assessment items. The development of questionnaire items for the surveys will not be so demanding because instruments from the M1 survey will be a starting point for the development.

SCHEDULE

Originally the targeted year for SITES-M3 data collection was the 2001-2002 school year. However, the development of M2 took more time than expected, leaving insufficient time to prepare for M3 in the scheduled time. A revised schedule of the 2003-2004 school year is proposed for the main data collection, taking into account the timing of other international studies including PIRLS, TIMSS-R, and PISA. This means that most countries in the Northern hemisphere would conduct their main assessment and surveys early in 2004 and most schools in the Southern hemisphere, would collect their data late in 2003.

Because new assessment instrumentation will have to be developed and tested well in advance, the project will need to begin soon, allowing for development time including pilot tests and pre-pilots of instruments. The following overall schedule is proposed.

Figure 9. Condensed Time Schedule

KEY DATES	KEY EVENTS
02/01	Startup
02.02	NRC meeting (finalize design, review instruments)
09/02	NRC meeting (final instruments, sampling plans)
11/02	ICC Ready for pilot
02/03	Conduct pilots
03/03	NRC meeting to review issues from pilots
04/03	Pilot data to ICC
08/03	NRC meeting to finalize instruments, procedures
10/03	ICC ready for main data collection
11/03	Data collection in southern hemisphere
05/04	Data collection in northern hemisphere
08/04	Data to ICC
06/04	NRC meeting on data cleaning, sampling, etc
10/04	NRC meeting (data issues, reporting)
02/05	First draft report
05/05	NRC meeting (analysis, report reviews)
12/05	Final reports

A much more detail time schedule can be found in the tables of deliverables for both the ICC and NRCs. (See Appendix C.)

Organization and Funding

The first task in organizing the study will be to prepare a request for proposals to establish an International Coordinating Center (ICC). Like in other recent IEA studies, it is presumed that the ICC for SITES-M3 will be a consortium. Within this structure it is strongly recommended that the consortium partners are located in different regions of the world. There are several advantages of such an approach: (1) representation of a variety of perspectives, (2) more possibilities for designing and funding regional options within the study (e.g. for APEC countries, the EU, Northern America, etc.), (3) increased efficiency in monitoring within a region, (4) increasing potential for stronger commitment and support in different parts of the world.

Fund raising should begin concurrently with setting up the ICC Consortium. Proposals could be developed right away for funding of one or more of the five special development projects described above. If special project funding is secured, it would be possible to start one or more of these projects prior to securing full funding for the entire project. Any special development projects should begin in 2001 as early as possible and would have to be completed by the third quarter of 2002.

The tables of deliverables in Appendix C contain estimates of approximate days of effort required for each deliverable for the NRCs as well as the ICC. The time frame for the ICC is basically 5 years beginning in early 2001 and the time frame for NRC projects is approximately 4 years beginning in late 2001. It is estimated that the cost of the ICC will be about 1 million USD for each of five years, with about 25% of that cost going to the DPC. The estimates of days of effort were made under the assumption that all three populations would be investigated, but each country would participate in an average of only two populations each. Also, it was assumed that about 25 countries will participate. A minimum of 150 schools are required for each population, and it was assumed that average of 10 teachers would respond from each school and about 20 students from each school. The estimates of effort do not include any special development projects. These estimates are very rough and should be considered preliminary. They are provided merely to help us get an overall sense of the cost of the project and the approximate time period that the costs would be incurred. More refined estimates of time and costs will be provided at the GA meeting in October. If it appears that funding for the international component of the study is not likely to be forthcoming, the overall project can be scaled back by dropping population 3, by reducing sample sizes, or by reducing the number of assessment items. This should be considered only as a last resort.

7. IMPLICATIONS OF THE STUDY

From top government leaders on down to teachers in their classrooms all face decisions about whether and how to integrate ICT into teaching and learning. Most of these decisions are not easy because the choices are sometimes complex, technically demanding, and the effects often not known. And of course the technology keeps changing. Even those who would be leaders in educational ICT, there is little research to base their decisions on.

The SITES-M3 study will not provide all of the answers that these decision-makers need, but it will help provide some important answers. This will be discussed in terms of key decisions needing to be made at two different policy decision-making levels: cross-national and national; and school leadership. The research results have relevance to decisions at other levels, e.g., community, parents, and teachers, but these are the two areas where a great deal, if not most, of the policy decision-making resides.

Cross-national and National. During the first two quarters of 2000 a flurry of high-level policy actions were taken with regard to ICT and education. In January 2000 the European Commission (EC) issued a report "Designing Tomorrow' s Education – Promoting Innovation with New Technologies." This detailed report recommended specific actions for improving utilization of current knowledge for effective implementation of ICT-based systems; improved management practices that utilized innovations more extensively; and a greater focus upon educational quality in all such practices. A few months later the European Commission (EC) established the eLearning initiative (europa.eu.int) to speed up activity in this direction. eLearning sets several very ambitious goals: (1) by the end of 2001 all schools and “public centres” will have Internet access and multimedia resources; (2) by the end of 2002 all teachers will have not only access to these resources but training in their use, and (3) by the end of 2003 all pupils will be digitally literate by the time they leave school. Given the diversity of the EU countries, these goals are indeed ambitious but significantly their articulation signifies the acceleration of education change related to ICT.

The Group of Eight (G8) meeting in Okinawa, Japan on July 24, 2000 became the first major summit to seriously address the digital divide and related ICT challenges. The very top leaders of France, Italy, Japan, Russia, Canada, Germany, United Kingdom, the United States, and the European Union issued a statement called the “Okinawa Charter on Global Information Society,” (http://www.library.utoronto.ca/g7/g20/) which said “We are committed to provide all our citizens with an opportunity to nurture IT literacy and skills through education, lifelong learning and training. We will continue to work toward this ambitious goal by getting schools, classrooms and libraries online and teachers skilled in IT and multimedia resources. We will also encourage the use of IT to offer innovative lifelong learning opportunities, particularly to those who otherwise could not access education and training.” This remarkable report from the G8 identified several groups requiring special assistance in accessing IT-related opportunities: “the socially under-privileged, people with disabilities, and older persons.” The G8 promised to actively pursue measures to facilitate access and use for these groups. Their first measure was the establishment of the “Digital Opportunity Task Force (DOT),” called the DOT Force, “to bring the poorest nations into the digital technology mainstream.”

Many top-level international and national policy makers have committed their governments to taking bold, new steps to utilize ICT in education more extensively. But there are few monitoring systems in place that will give them evidence of impacts, either positive or negative, that may result from these actions. SITES-M3 will produce major indicators that will make it possible to profile schools, teachers, and students with respect to their use of ICT and their skills in using it, specifically for knowledge management purposes. These indicators will not only make it possible to chart progress but to identify learning gaps and areas wheregreater attention needs to be given. Perhaps most importantly the indicators will provide data on the digital divide, especially from comparisons across countries that differ in wealth and other resources.

School Leadership. Many school principals, ICT directors, and teachers are also looking for knowledge that would offer guidance in their decisions about ICT. Most school administrators are faced with decisions about ICT-related priorities and how much to spend on equipment, software, and services. They want to know how to allocate the resources so as to improve learning for all students. They want to know how to prepare themselves and other staff to be ICT-ready.

There are lots of theories but few hard facts to answer these questions. That is why the findings from SITES-M3 can make a difference. The results will implicitly offer a variety of benchmarks against which a school of a given type can be compared. The findings will also provide a variety of models of school policies and teaching practices that school leaders may not have known about.

A recent study by Nancy Law and associates (1999) found that leadership, especially at the school level, made a big difference in terms of pedagogical improvements in teaching as well as student learning. They concluded that “One very important aspect of school leadership is whether the school has established explicit ICT policy goals and specific implementation plans for the current school year and beyond.”

These are the kinds of findings that SITES-M3 can achieve with its design linking together student outcomes, teaching practices and characteristics, and school contexts. It will be possible to identify specific policy actions that schools can take, knowing that schools with such policies tend to have teachers and/or students that utilize ICT more effectively and demonstrate higher levels of ICT knowledge management.

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APPENDIX A: THE IEA SITES-M1 SUMMARY

Organization

The International Coordinating Center (ICC) of SITES Module-1 was located at the University of Twente, Center for Applied Educational research (OCTO) in the Netherlands. The International Coordinator was Dr. W.J. Pelgrum, and the Co-Chairs of the International Steering Committee for the study were R. E. Anderson, University of Minnesota, and T. Plomp, University of Twente. The sampling coordinator for the study was Dr. C.A. O'Muircheartaigh of the NORC and a professor at the University of Chicago.

The funding for the international coordination was provided by the ministries of education from Japan, the Netherlands, and Norway. A further contribution to funding came from the participation fees that were provided by the participating countries. Each of the countries was represented by a National Research Coordinator who was responsible for collecting the survey-data in their country following guidelines that had been agreed upon by all participants.

Participation

Technical details of the sample and study methodology are available at http://www.mscp.edte.utwente.nl/sitesm1. Participating in M1 were several Asian countries: Chinese Taiwan, Hong Kong, Japan, Singapore, and Thailand. From Eastern Europe were Bulgaria, Czech Republic, Hungary, Latvia, Lithuania, Russia, Slovenia, and the Slovak Republic. Eight Western European countries participated: Belgium-French, Denmark, Finland, France, Iceland, Italy, Luxembourg, and Norway. There were three additional countries in the study, Canada, Cyprus, and New Zealand. South Africa and the Russian Federation sampled from only a few of their regions and were therefore not representative of their entire school systems. These two countries were excluded from some of the analysis.

Findings

The complete report from the study as published by the IEA (Pegrum and Anderson, 1999). Seven of the tables from the study were recently published in the OECD publication, *Education at a Glance, 2000*. Here we will just note some of the highlights of the findings.

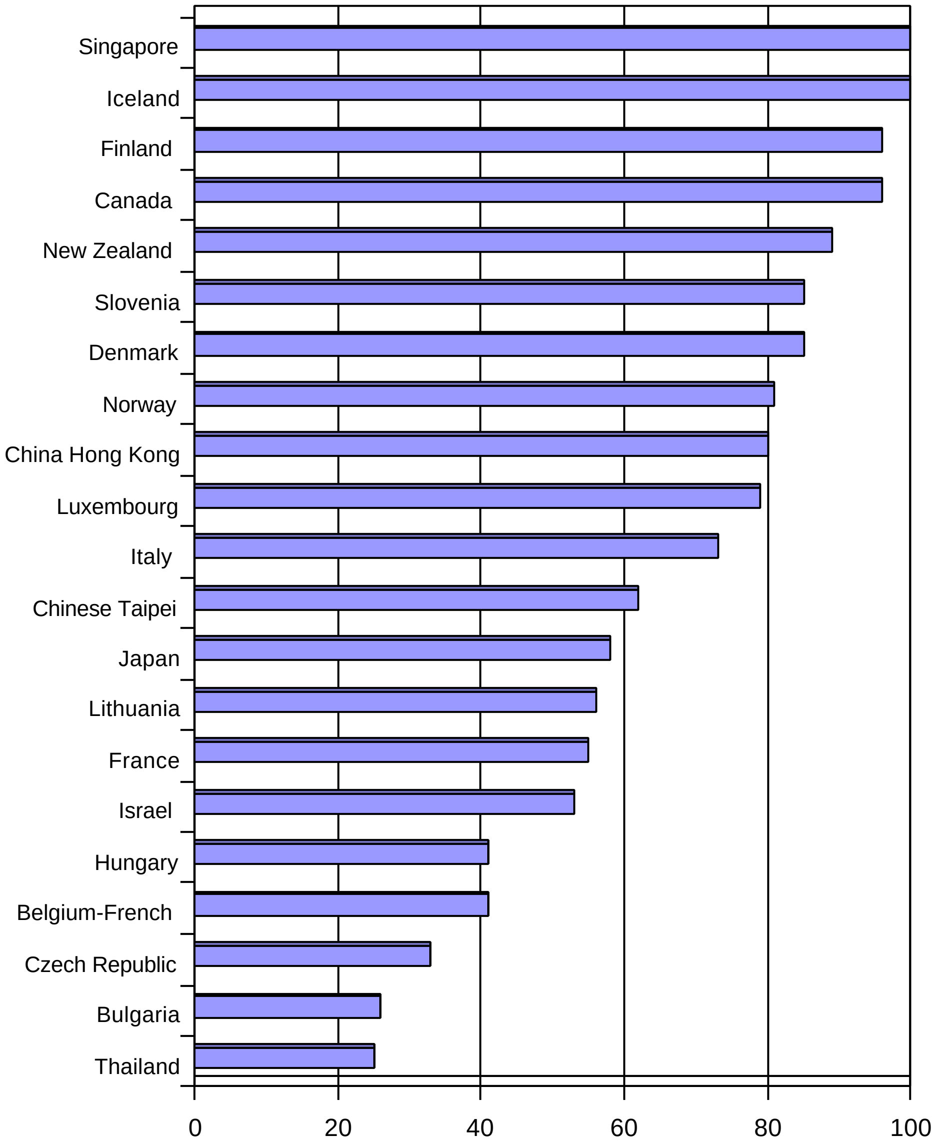
<u>Computer Density.</u> The infrastructure, as measured by computer density, has been doubling every three to five years in most participating countries. The typical county cut their student-computer ratios by slightly more than a half between 1995 and 1998. The major exceptions to this pattern were several countries including Hong Kong, Norway, Slovenia, and Thailand, in which their computer densities more than tripled. In these cases the dramatic change resulted from national programs to expand the IT infrastructure in education.

Multimedia Capacity. An increasingly common indicator of whether or not the ICT is adequate for contemporary applications is the percentage of school computers that are multimedia-ready. This generally means that at a minimum the computer has a CD-ROM drive and a sound card. In most of our countries, the average percent of computers that were multimedia-ready, ranged in primary schools between 50 and 75 percent, whereas at the lower secondary it ranged between 25 and 50 percent. This pattern of favoring the lower grade levels probably results mostly from the fact that most countries introduced computers into the higher grades much earlier. In recent years many countries have initiated programs to introduce more IT into the lower levels and hence their computers are newer and more likely to be multimedia ready. A large proportion of the computers in most countries still are not equipped for multimedia applications. Two major exceptions are Hong Kong and Singapore where almost all of their instructional computers could use multimedia. At the other extreme were some of the Eastern European countries. In these countries they installed many Apple II-equivalent computers some years ago.

Internet Access. The following bar chart shows that while 100% of the schools in Singapore and Iceland had access, some countries had only about a fourth of their schools connected. Most of the other countries had connected over 50% of their schools. What is so remarkable about this pattern is that even in countries that do not speak the dominant language of the Internet, English, most of their schools had been connected and many of the students were using the Internet in school. This rapid connection of schools to the Internet occurred within only about five years or less.

Pedagogical Practices. Principals and technology coordinators were asked about the role in their school of teaching practices which fit the EP (emerging paradigm of pedagogical practices). Practices involving ICT knowledge management pedagogies were reported in many schools in most countries. Furthermore, in many instances the principals selected them as the ICT-based teaching practices with which they were the most satisfied.

Average Percent of Lower Secondary Schools with Internet Access, 1998 IEA SITES



Appendix B: M2 Summary

PROSPECTUS: Research Design for SITES-M2 : Qualitative Studies of Innovative Practices

The skyrocketing pace of new information and communications technology (ICT) inventions, particularly applications of the Internet and the World Wide Web (WWW), has prompted increased interest in information technology around the globe. Recent reports issued by UNESCO and the World Bank advocate the use of these new technologies to promote international socio-economic progress and educational change, both inside and outside the classroom. Countries from Chile to Finland and from Singapore to the US have all set national goals and policies that identify a significant role for ICT in improving their education systems and preparing their students for the Information Society of the 21st century. Yet in most countries, there are a relatively small number of schools and teachers who are taking the lead in using technology to change pedagogical practices. How are these innovative teachers succeeding in their use of ICT to change pedagogy? What school organizational practices, national polices, and other contextual factors are contributing to their success? What can policy makers and other teachers learn from these innovations?

These are the basic questions addressed by the Second International Technology in Education Study (SITES) Module 2. SITES Module 2 (M2) is a qualitative study of classrooms that use innovative technology-based pedagogical practices. In each participating country, national panels will use common selection guidelines modified by local criteria to identify innovative classrooms. National research teams will use common methods to analyze the pedagogical practices of teachers and learners, the role that ICT plays in these practices, and the contextual factors that support and influence them. Implications will be drawn for both improved policy and classroom practices.

Currently, more than 20 countries have indicated their interest in participating in the study. These countries are from North America, Western and Eastern Europe, Asia, and Africa. Additional countries may yet join. We are particularly interested in extending the reach of this study to include developing countries, to work with them to develop their evaluation capacity, and to look at the unique role that ICT may be playing to advance their development.

The Three Modules of SITES

SITES is a study in three modules authorized by the International Association for the Advancement of Educational Achievement (IEA). Module 2 (M2) of SITES is a series of qualitative studies that identify and describe innovative pedagogical practices that are supported by technology. M2 builds on Module 1 (M1) and contributes to the subsequent Module 3 (M3) of SITES. Conducted in 1998-1999, M1 was a survey of principals and technology coordinators at a sample of schools in 26 countries. The focus of M1 was on the extent to which schools have adopted and implemented pedagogical practices that are considered important to education in the Information Society. M3 is an assessment of teachers and students and focuses on the impact of ICT on the skills students will need for the Information Society.

M2 builds on M1 in that it looks in detail at innovative technology-supported classroom practices and tests the validity of some of the M1 indicators. It also examines the contextual factors that influence these practices. M2 will contribute to M3, in that it will further identify the competencies of students and teachers that are emerging from innovative technology-supported pedagogical practices. These competencies will be assessed in M3.

Goals of the Study

More specifically, the goals of SITES M2 are:

- To identify and describe innovative pedagogical practices that use technology. The case studies will focus on innovative practices in each country—instances where the uses of ICT contributes to significant improvements, as locally defined.

- To inform national and local policies related to ICT that can advance a country' s educational goals and address educational needs and problems.
- To provide teachers and other practitioners with new ideas about how they can use ICT to improve classroom practices.
- To add to the body of research knowledge and theory about the factors within and across countries that contribute to the successful and sustained used of innovative technology-based pedagogical practices.
- Too investigate the measurement quality of M1 indicators and contribute to the development of M3 assessments.

Research Questions

The goals of project suggest the following sample research questions. The SITES M2 study will address the following questions that *inform policy decisions*:

- How does the use of ICT address the educational goals, problems, and needs of various countries? How do countries differ in these goals, problems, and needs and the ways they use ICT to address them?
- Which national policies in curriculum, assessment, pedagogy, and professional development are effective in supporting different innovative technology-based pedagogical and curricular practices? In what ways are these policies coordinated and aligned within countries?
- Which national telecommunications policies related to school Internet access, equipment purchase, teacher training, student Internet use, and other issues are effective in supporting innovative technology-based pedagogical practices that advance national goals?
- Which local polices related to staff development, student computer fees, facilities access, technical support, and other issues are effective in supporting these innovations?

The SITES M2 study will address the following questions that can contribute to *improved classroom practice*:

- What are the innovative pedagogical practices in which teachers use ICT?
- How do these practices change what teachers and students do in the classroom? In what ways do teachers and students use technology to change the pedagogical methods they use and the roles that they take? How does this affect patterns of teacher-student and student-student interactions?
- What impact do these practices have on student competencies, attitudes, and other outcomes? How have these practices changed the ways these outcomes are assessed?
- How do these practices change the classroom? In what ways does the use of ICT change the organization of the classroom, extend the school day, break down the walls of the classroom, and involve other actors in the learning process (such as parents, scientists, business people, etc.)?

The SITES M2 study will answer the following questions to *advance knowledge and build theory*:

- What teacher and student characteristics and capabilities support and enable innovative practices? How do the practices change, in turn, the teachers' skills and capabilities? How does technology affect student learning?
- What capabilities of the technology support these innovative pedagogical practices? How do these capabilities shape the practices they support?
- What are the local and national contextual factors associated with the use of innovative pedagogical practices that use technology? Which factors seem to be present across different innovative pedagogical practices? Which ones are associated with different practices?

- How do these findings contribute to theories of educational change and school learning?

The SITES M2 study will answer the following questions to *SITES MI and M3 connections*:

- To what extent do the instruments used in M1 yield valid information on school pedagogical practices and school context?
- What changes in teacher and student competencies are associated with the innovative use of ICT and how should these competencies be assessed in M3?

Advantages of an International Comparative Study

The case studies from a broad range of participating countries will be used in cross-national studies to identify trends and patterns that cut across national and cultural boundaries. The international, comparative nature of this study will allow policy makers to see ways in which ICT may be changing education world-wide. Yet the comparative nature of the project will also allow an investigation of the ways in which international trends are reshaped to accommodate local cultural, political, and historical factors.

Consequently, the study will help policy makers compare the ICT policies and practices in their own country to other countries with similar educational goals, problems, and needs. This comparison might identify new ideas and policies developed in other countries that might address these goals, problems, and needs.

Advantages of the Qualitative Approach

The qualitative case studies of SITES M2 are designed to complement the more quantitative M1 and M3 studies. The added advantage of the qualitative research approach is that it provides much more detailed information on people, events and practices. This is particularly important as we explore some of the trends identified in M1. Furthermore this approach examines these people and practices in their natural context. Consequently, the approach can identify and describe the complex interactions and interrelationships among factors in a system. This is particularly important in an international study where cultural and other contextual differences can be significant explanatory factors. Finally, the more open-ended nature of qualitative research allows for the emergence of novel findings that may not be anticipated when designing a quantitative instrument. This is a particularly important advantage when examining innovative practices and exceptional situations.

Methodological Approach for SITES M2

Case Selection

SITES M2 will conduct intensive case studies of classrooms selected because of their use of technology to support innovative practices. Between 4 and 12 cases will be selected for each country, depending on the grade levels chosen for participation in the study.

In the SITES M2 we strike a methodological balance between the accommodation of local context and the requirements of standardization and common practice. For case selection, this balance is achieved through the use of national panels who represent policy makers, administrators, teachers, and other experts. The panels will use a standard set of guidelines issued by the International Coordinating Committee (ICC) that will shape their work. The guidelines specify that selected innovations should be those in which technology plays a substantial role; in which significant changes are made in roles of teachers and students, the goals of the curriculum, and/or the educational materials or infrastructure; which result in measurable student outcomes; and which are sustainable and transferable. The panels will modify these guidelines in ways that emphasize national goals, needs, and problems, and they will use them to select outstanding classrooms for study. Standardization will also be accomplished through accountability procedures by which panels coordinate their selections with the ICC.

Data Collection and Analysis

Case studies of selected classrooms will be conducted by national research teams using common data collection and analysis protocols and these studies will be coordinated and monitored across countries by the International Coordinating Center (ICC). Research teams will spend approximately five days over two separate visits to each school. They will collect data from each of the selected classrooms and their schools and local communities. Sources of data will include:

- Interviews of administrators, teachers, and students, and, where relevant, parents and other community members.
- Archival or historical data, such as project proposals, progress reports or annual reports.
- Program materials, such as teacher lesson plans, instructional materials, curriculum guides, software, reports, assessment instruments, etc.
- Students' products, such as reports, projects, tests, and student-generated web sites, as well as teachers' analyses of these.
- Classroom observations that describe teacher and student behaviors, teacher-student and student-student interactions, seating arrangements, computer placement and resource allocation, etc.

Classroom observations will be made of at least 4 class sessions over the 2 visits to each school. Every attempt will be made to collect data on a set of sessions that constitute at least one extended curricular unit or project.

Case analyses will describe the uses of ICT and the innovative pedagogical practices found in these classrooms. The analysis in these cases will focus on the way these practices are changing the roles of teachers and students, the kinds of learning and student products that are associated with these changes, and the role ICT is playing in bringing these changes about. The influence of contextual factors will also be analyzed—factors such as school organization and leadership, community involvement, and national policies and programs related to educational improvement and ICT implementation. Cross-case analyses with allow statements to be made about trends in these findings within and across countries.

Reporting and Dissemination

Three types of reports will be issued by SITES M2:

- A report from each country that defines a criteria for selecting innovative technology-based pedagogical practices within a context of national goals and needs for educational improvement, describes and implements a process for selecting such innovative practices, and presents a set of case studies of classrooms in which these innovations are occurring in that country.
- A cross-national report, in which examines the common themes across countries and distinctive roles that ICT may play in pedagogical practices, relative to local contexts and the goals and needs of different countries.
- Reports on optional studies that will be defined by the International Coordinating Center and that individual countries may or may not join.

A project Web site will be maintained that will support collaboration and the exchange of information, that will disseminate findings, and that will support the customized search of the case study database. The audiences for these studies and resources are educational policy makers, researchers, administrators, practitioners and the general public around the world who can use the findings to implement technology-based education improvement.

Optional Studies

In addition to the required core or main study, SITES M2 will offer several optional studies in which countries may choose to participate. These include:

- A video study that supplements case data with video footage of classroom practice and connects the study to the TIMSS R Video study.
- Case studies of uses of ICT that go beyond or outside the classroom. These might be cases that connect the classroom to homes, the work setting, scientific institutions, or tertiary institutions so as to change the structure of learning and teaching or involve new people in the process

- Case studies that particularly focus on the use of ICT in math and science, with an emphasis on new applications of technology designed specifically for these fields (such as visualization or modeling software) and how these are changing what is taught and learned in math and science.

OECD Cooperation

The Organization for Economic Cooperation and Development (OECD) is conducting a somewhat similar study that focuses on the effect of ICT on school culture and organization, rather than its effect on classroom practices. The SITES M2 ICC is coordinating with the OECD research group to minimize conflicts and maximize potential payoffs of these two studies.

SITES M2 Study Schedule

The SITES M2 study will be conducted from 1999-2002. The following schedule of activities has been adopted:

International Coordinating Center

IEA-sanctioned studies are designed and directed by an International Coordinating Center (ICC). The ICC for SITES M2 is a consortium of four institutions headed by the Center for Technology in Learning (CTL) at SRI International (USA) and directed by Dr. Robert Kozma. The other researchers and organizations collaborating in the ICC consortium are: Dr. Ray McGhee, SRI Center for Technology in Learning (USA); Drs. Joke Voogt and Willem Pelgrum, the Center for Applied Educational Research at the University of Twente (NL); Dr. Ron Owston, the Center for the Study of Computers in Education at York University (CA); and Dr. Richard Jones, the Education Quality and Accountability Office (CA). Dr. Ronald Anderson, University of Minnesota (USA), and Dr. Tjeerd Plomp, Twente University, are ex-officio members, as co-Chairs of the IEA SITES Steering Committee.

SITES M2 Study Schedule

The SITES M2 study will be conducted from 1999-2002. The following schedule has been adopted:

1999: Develop conceptual framework and design of the core and optional studies; raise funds; recruit participating studies; establish national panels of stakeholders in each country for dialogue on innovative pedagogical practices using technology and case selection; create web database displaying examples of IPPUT's; develop protocols and instruments; pre-piloting of initial designs in various countries (USA, Canada, Netherlands, Africa and others); National Research Coordinators' (NRC's) meeting for review of conceptual framework, research questions and indicators, pre-pilots, criteria for site selection, selection protocol, and data collection; development of Web-oriented database for information sharing among the national research teams.

2000: NRC's select sites and conduct pilot studies; ICC-NRC Meetings discuss code schemes, data management, data analysis procedures, and reporting format; use of web-based resources to share information and communicate about innovative pedagogical practices, data collection and analysis; follow-up visits by ICC to selected countries.

2001: Continuation of data collection, country-level data analysis; cross-national analysis of data; optional studies conducted.

2002: Reporting and dissemination.

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APPENDIX C(a). ICC Deliverables, Schedule & Estimated Effort*

(Note: This is a draft table; a new version will be provided at the GA meeting, Oct. 2000)

Deliverables	Category	Start Date	End Date#	DAYS**
Start up	Manage	Feb-01	Mar-01	25
Update specification of deliverables	Manage	Feb-01	Mar-01	5
Designate assignments of deliverables	Manage	Feb-01	Mar-01	5
Finalize details of ICC budget	Manage	Feb-01	Mar-01	10
Assist with proposals for funding of main study	Manage	Feb-01	May-01	90
Finalize proposals for special projects	Manage	Feb-01	May-01	50
Staffing of ICC	Manage	Feb-01	Jun-01	60
Review composition of ISC & establish communication	Manage	Feb-01	Jun-01	20
Web site design for communication & managing	Manage	Feb-01	Jun-01	35
Refine conceptual frameworks and research questions	Planning	Feb-01	Mar-01	25
Web site design for reporting	Reporting	Feb-01	Apr-01	25
Develop plan for curriculum analysis	Planning	Mar-01	Apr-02	15
Develop alternative plans for translation reviews	Planning	Apr-01	Apr-01	15
Develop specifications for tests and questionnaires	Instruments	Apr-01	Apr-01	35
Establish expert int'l panel on ICT & Ed. trends	Manage	May-01	Jul-01	20
Appoint Sampling Referee	Manage	May-01	Jul-01	4
Appoint Data Quality Monitor	Manage	May-01	Jul-01	5
Update sampling design and procedures	Planning	May-01	May-01	25
Update analysis plan*	Planning	May-01	May-01	15
Test development (3 populations)	Instruments	May-01	Oct-01	120
Questionnaire development (4 for each of 3 pops.)	Instruments	May-01	Oct-01	120
Performance test development (3 populations)	Instruments	May-01	Oct-01	90
Update plans for data collection	Planning	Jun-01	Jun-01	25
Update reporting and dissemination plan	Planning	Jun-01	Jun-01	15
Update plans for quality assurance	Planning	Jul-01	Jul-01	25
Survey NRCs regarding sampling constraints	Sampling	Oct-01	Dec-01	25
Plan & arrange ISC/NRC meeting #1	Manage	Dec-01	Feb-02	25
Develop Translation and verification procedures	Instruments	Jan-02	Jan-02	35
Develop sampling manual, finalize policies	Sampling	Feb-02	Feb-02	25
Coordinate curriculum analysis	Planning	Apr-02	Dec-02	35
Develop plan for international options	Planning	Apr-02	Apr-02	25
Solicit national sampling plans	Sampling	Apr-02	Apr-02	15
Plan & arrange ISC/NRC meeting #2	Manage	Jun-02	Sep-02	25
Review national sampling plans	Sampling	Jun-02	Aug-02	25
Assist with drawing samples	Sampling	Sep-02	Jan-03	10
Develop manuals for data entry, coding and scoring	Data	Sep-02	Dec-02	25
Develop data entry, coding, cleaning plan	Data	Sep-02	Sep-02	15
Finalize Pilot-study data collection instruments	Instruments	Oct-02	Oct-02	25
Finalize field-test administration manual	Instruments	Oct-02	Oct-02	25
Solicit national data collection plans	Data	Oct-02	Oct-02	25
Review national data collection plans	Data	Nov-02	Nov-02	25
Refine data collection quality control procedures	Data	Nov-02	Nov-02	15
Prepare international codebook	Data	Nov-02	Nov-02	45
Translation checks	Instruments	Nov-02	Dec-02	35
Translation checks	Instruments	Nov-02	Dec-02	35

Plan & arrange ISC/NRC meeting #3	Manage	Jan-03	Mar-03	25
Coordinate pilot	Data	Feb-03	Mar-03	35
Process pilot data (cleaning & file generation)	Data	Mar-03	Apr-03	100
Plan & arrange ISC/NRC meeting #4	Manage	Apr-03	Aug-03	25
Update instruments and manuals after pilot	Instruments	Apr-03	May-03	15
Analyze & report pilot	Data	Apr-03	Jun-03	35
Solicit data quality reports	Data	Apr-03	Apr-03	15
Review data quality reports	Data	Jun-03	Jun-03	25
Update administration manual	Data	Jul-03	Jul-03	15
Coordinate main data collection	Data	Oct-03	May-04	35
Review sampling reports	Sampling	Feb-04	Apr-04	35
Plan & arrange NRC meeting #5	Manage	Apr-04	Jun-04	25
Calculate sampling weights	Data	May-04	Jul-04	25
Process data (cleaning & file generation)	Data	Mar-04	Sep-04	800
Document sampling and non-sampling errors	Analysis	Aug-04	Aug-04	50
Validate constructs and scales for analysis	Analysis	Sep-04	Sep-04	35
Prepare tables, graphs & send to NRCs	Reporting	Sep-04	Oct-04	35
Plan & arrange ISC/NRC meeting #6	Manage	Sep-04	Oct-04	25
Data files to NRCs	Data	Nov-04	Nov-04	25
Revise tables, graphs	Reporting	Nov-04	Nov-04	35
Produce descriptive statistics	Analysis	Nov-04	Nov-04	35
Prepare draft report 1	Reporting	Jan-05	Mar-05	65
Prepare draft report 2	Reporting	Jan-05	Apr-05	65
Prepare draft report 3	Reporting	Jan-05	May-05	65
Arrange for PEC review of reports	Reporting	Jan-05	May-05	15
Conduct multivariate statistical analysis	Analysis	Jan-05	Mar-05	35
Plan & arrange ISC/NRC meeting #7	Manage	Feb-05	May-05	25
Arrange for release of reports (3)	Reporting	Apr-05	Aug-05	10
Prepare technical report	Reporting	Apr-05	Sep-05	145
Finalize report 1	Reporting	May-05	Sep-05	25
Finalize report 2	Reporting	Aug-05	Oct-05	25
Finalize report 3	Reporting	Nov-05	Nov-05	25
Review by publisher/copy editing	Reporting	Nov-05	Dec-05	25
Release data and data archive documentation	Reporting	Dec-05	Dec-05	15
				3,384

#Date format is month and last two digits of year.
*For the ICC estimates, it is assumed that 25 countries will participate in two populations each. A minimum of 150 schools are required for each pop, with each school have an average of 10 teacher questionnaires and and average of 20 students tested. The above estimates of effort do not include any special development projects.
**For purposes of a rough initial estimate of effort we have not distinguished hours by job category.

APPENDIX C(b). NRC Deliverables, Schedule & Estimated Effort*

Deliverables	Category	Start Date	End Date#	DAYS**
Funding arrangements for national project	Manage	Feb-01	Feb-02	40
Staffing arrangements for national project	Manage	Feb-01	Feb-02	15
Select National Steering Comm.	Manage	Apr-01	Apr-02	15
Participate in NRC meeting #1	Manage	Feb-02	Feb-02	5
Conduct curriculum analysis	Planning	May-02	Nov-02	25
Finalize national project plan	Planning	May-02	Jun-02	25
Plan and develop national options	Planning	May-02	Jun-02	15
Sampling plan (including frame) to ICC	Sampling	May-02	May-02	15
Participate in NRC meeting #2	Manage	Sep-02	Sep-02	5
Revise sampling plan as needed	Sampling	Sep-02	Sep-02	10
Draw samples	Sampling	Oct-02	Oct-02	15
Translate pilot instruments	Instruments	Nov-02	Nov-02	30
Translate administration manual	Instruments	Nov-02	Nov-02	20
Conduct pilots	Data	Jan-03	Feb-03	35
Data entry and initial cleaning	Data	Feb-03	Mar-03	5
Participate in NRC meeting #3	Manage	Mar-03	Mar-03	5
Data to ICC	Data	Mar-03	Mar-03	5
Translate final instruments	Instruments	Jul-03	Nov-03	15
Precoding instruments	Instruments	Jul-03	Nov-03	10
Data collection plan to ICC	Data	Jul-03	Jul-03	5
Participate in NRC meeting #4	Manage	Aug-03	Aug-03	5
Select and train data collection staff	Data	Aug-03	Jan-04	15
Recruit school participation	Data	Oct-03	Apr-04	30
Send Instruments to schools	Data	Oct-03	Apr-04	20
Data collection	Data	Oct-03	May-04	45
Data entry and initial cleaning	Data	Oct-03	Jun-04	40
Open Coding and file creation	Data	Dec-03	Jun-04	36
Document national data collection	Data	Jan-04	Jun-04	15
Sampling report to ICC	Sampling	Jan-04	Jun-04	5
Data to ICC	Data	Feb-04	Aug-04	25
Participate in NRC meeting #5	Manage	Jun-04	Jun-04	5
Prepare data quality reports	Data	Apr-04	Jun-04	15
Review draft tables	Reporting	Aug-04	Sep-04	5
Analyze data for national report	Analysis	Sep-04	Apr-05	45
Write national report	Reporting	Sep-04	Apr-05	50
Participate in NRC meeting #6	Manage	Oct-04	Oct-04	5
Review draft report 1	Reporting	Feb-05	Feb-05	15
Review draft report 2	Reporting	Mar-05	Mar-05	15
Review draft report 3	Reporting	Apr-05	Apr-05	15
Participate in NRC meeting #7	Manage	May-05	May-05	5
				726

#Date format is month and last two digits of year.
*The estimates of time for NRCs will depend mainly upon the number of populations in which they participate.
For the above estimates, participation in only 2 populations was assumed.
**For purposes of a rough initial estimate of effort we have not distinguished hours by job category.