The final substantive outcomes of MATEN are a set of courses, that teach CIT and the English language in a set of contexts: education, business, and computing. Each course also develops transferable skills with new technologies and language. There was also considerable staff development and, in the case of English language, this grew into an award-winning course delivered through telematics to English teachers in higher education.

Conclusions

The result of the series of East-West cooperative projects so far has been a continuous reflection on the nature of learning and a revitalization of the ancient question, how schooling efforts can help restructure society in general and an economic system in particular. The concise review of ongoing Tempus and Copernicus projects shows that the major appreciation of ICT is in its flexibility, its just-in-time nature, and its orientation toward students as customers. These opportunities and the articulations of unorthodox schooling paradigms make it quite complex for traditional institutes to ntegrate the benefits of ICT-supported learning nto practice. Adjacent ongoing Tempus projects ihow that traditional state-driven universities ieed to be structured as entrepreneurial rather han academic organizations. At the same time here is a general lack of commitment by the highly 'ersatile commercial training enterprises. A third lternative is the so-called "learning communities" hat attempt to establish mutual learning as an ngoing process, without any institutional basis. It s unclear at this moment how the balance between ie three will gradually evolve in Eastern Euroean countries in the coming years. Having partic-ated in ongoing Tempus and Copernicus rojects and at the same time having seen the ynamics of new, young, up-and-coming entrereneurs that play a role in the free market, it is my cpectation that they finally will become dominant the propagation and dissemination of expertise. ooking from the aspect of societal reform, how-'er, it is my estimation that further investments in J projects should continue in the direction of tranational state schooling institutes as they are able to aintain the momentum of evolution of a learning lture in the long run. □

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Information and Communication Technology (ICT) in Lower Secondary Schools in Bulgaria, the Czech Republic, Hungary, Lithuania, and the Russian Federation

by W.J. Pelgrum and J.M. Voogt

□ This article shows some of the results of an international comparative assessment of information and communication technology (ICT) in education, which was conducted by the International Association for the Evaluation of Educational Achievement (IEA) at the end of 1998. It is shown that the countries in Central and Eastern Europe did not differ systematically from countries in other parts of the world with regard to emphasis on traditional or emerging pedagogical paradigms. However, in terms of ICT infrastructure, systematic differences were observed.

Introduction

In 1998, the International Association of the Evaluation of Educational Achievement (IEA) conducted a survey among representative samples of schools at three educational levels (primary, lower secondary, and upper secondary) in roughly 25 countries. Seven countries from Central and Eastern Europe participated in this survey. The results of the survey are available in Pelgrum and Anderson (1999), which is also the major source for this article.

In this article we will describe a selection of results for those countries from Central and Eastern Europe that participated at the lower secondary level, which was the core population in Module-1 of the Second Information Technology in Education Study (SITES). At this level the retentivity in all educational systems is very high.

After a summary of SITES, this article will provide a summary of results for the following aspects of the lower secondary-school environment:

- Infrastructure
- Curriculum
- Emerging practices

In the final concluding section the question will be addressed, To what extent does the implementation of ICT in Central and Eastern European schools appear to be different from what happens in other countries?

Summary of SITES

ICT is currently seen as having the potential to facilitate changes in education that will allow future citizens to be better prepared for the information society than is currently the case. Many policy documents speculate about the directions that such change might take in creating the "school of tomorrow." Table 1 provides an overview of some of these common expectations.

One may argue that the changes mentioned in Table 1 do not necessarily imply the use of ICT. However, ICT tends to play a facilitating role in managing the increased flows of information associated with more autonomous learning environments. Such information flows support subject matter content (that can be located outside schools), the monitoring of progress (particularly individual student learning progress, with increased feedback to parents), individualized self-assessment options, and individualized educational career planning.

The Emerging Paradigm

SITES participants labeled the distinction in Table 1 between education in the industrial society and education in the information society as the traditionally important paradigm versus the emerging paradigm. Alternative labels for the emerging paradigm, such as *life long learning* and *constructivism*, were considered but avoided because of their more narrow connotations. The concept of the emerging paradigm (versus the traditionally important paradigm) provided a useful overarching structure for the conceptualization and execution of the study.

SITES Module-1 was based on a conceptual framework in which the curriculum was conceived as the focus of the study. Instead of studying technology as the goal in itself, technology was conceived as a vehicle that can bring about and stimulate changes in the curriculum of schools. The participants in SITES agreed that the most widely expected change in education as a result of ICT would probably consist of changing pedagogical paradigms. The ICT infrastructure, management and organization of ICT, and ICT-staff development are conceived as potentially facilitating conditions for bringing about curricular change.

The Central and Eastern European countries included in this article are Bulgaria, the Czech Republic, Hungary, Lithuania, and the Russian Federation. Although Latvia and the Slovak Republic also participated in SITES Module-1, they only did so at the upper secondary level, which is beyond the scope of this article. For reference purposes the results from a few other European countries (Denmark, Finland, and France) as well as two countries from other regions in the world (Japan and Canada) are included.

Table 1 ☐ Expected changes from education in the industrial society to education in the information society (Pelgrum, ten Brummelhuis, Collis, Plomp, & Janssen Reinen, 1997)

Actor	*Education in the Industrial Society (the traditionally important paradigm)*	*Education in the Information Society (the emerging paradigm)*
School	• Isolated from society • Most information on school functioning confidential	• Integrated in society • Information openly available
Teacher	• Initiator of instruction • Whole class teaching • Evaluates student • Places low emphasis on communication skills	• Helps students find appropriate instructional paths • Guides students' independent learning • Helps student to evaluate own progress • Places high emphasis on communication skills
Student	• Mostly passive • Learns mostly at school • Hardly any teamwork • Takes questions from books or teachers • Learns answers to questions • Low interest in learning	• More active • Learns at school and outside school • Much teamwork • Asks questions • Finds answers to questions • High interest
Parent	• Hardly actively involved ins learning proces • No steering of instruction • No life-long learning model	• Very active in learning process • Costeering • Parents provide model

Table 2 ☐ Thirteen aspects of teaching and learning that were used to characterize participating schools in SITES Module-1

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

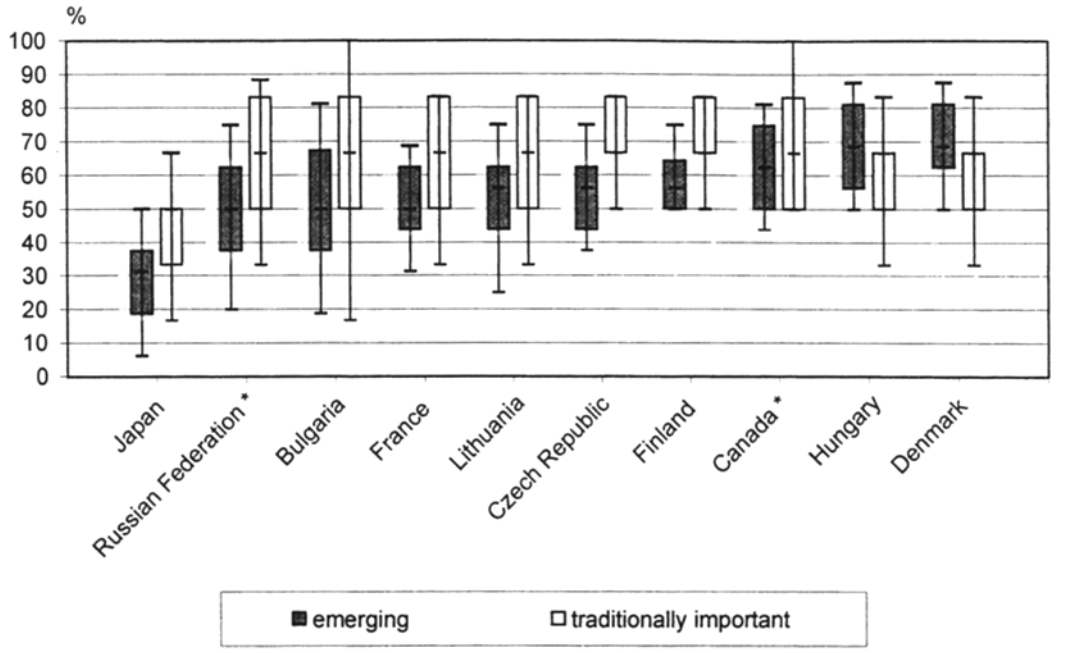
ICT and the Curriculum

The school principals who participated in SITES Module-1 were asked to what extent each aspect of teaching and learning that is listed in Table 2 was present in their school (the answer alternatives were *not at all, to some extent,* and *a lot*).

Empirical analyses (for further details, see Pelgrum, 1999) provided substantial evidence that statements 1, 2, 3, 4, 8, 9, 10, and 13 could be interpreted as reflecting emerging practices, while statements 5, 6, and 7 could be combined into indicators of traditionally important practices.

The box plots in Figure 1 provide a condensed summary of the median values for each country and the dispersion within countries of indicators on the emerging and the traditionally

Figure 1 ☐ Box plots of indicators concerning the emerging and traditionally important pedagogical practices paradigm for lower secondary education (ordered by the medians for emerging practices).



Notes: Boxes range from 25% lowest to 75% highest value (second and third quartile); the horizontal line in the boxes represents the median; tiles show values for 10% and 90% of the cases. *: country did not satisfy all sampling criteria (see Pelgrum & Anderson, 1999).

important practices. A general observation from Figure 1 is that the indicators vary quite substantially between as well as within countries.

Figure 1 reveals that for lower secondary education some countries (especially Denmark and Hungary) the presence of learning activities associated with the emerging practices was relatively high when compared with other countries. Relatively low median values on this indicator were observed particularly for Japan. In almost all countries (except Denmark and Hungary) the traditional paradigm seemed to be present to a larger extent than the emerging paradigm. Overall, the Central and Eastern European countries do not seem to be distinct (for instance, being more traditional) from the other countries.

In many countries, the introduction of ICT in the curriculum started with introducing new school subjects for learning *about* computers (Pelgrum & Plomp, 1993). However, gradually it seems that in many countries the stimulation of learning *with* computers is seen as the most important goal for the foreseeable future. In order to characterize the current objectives of schools, principals were requested to indicate, on the basis of the school's objectives, which skills students should have acquired by the time they had reached the end of lower secondary education.

Table 3 provides a description of these skills and the percentages of students at schools where principals checked each of the items in this list. In this table it is interesting to note that in Central and Eastern Europe programming seemed to be more valued than in the other countries. On the other hand, the percentages reported for modern applications such as e-mail and use of information seemed to be higher in Western Europe and Canada.

Table 3 ☐ Percentages of students whose school principals indicated that students should have acquired particular ICT-related skills by the end of the target grade-lower secondary education

		(percentages of values in Column 1)					
Country	1. *Operate a Computer* %	2. *Process Words* %	3. *Illustrate with Graphics* %	4. *Calculate with Spreadsheets* %	5. *Write Simple Programs* %	6. *Communicate via E-mail* %	7. *Use Electronic Information* %
Denmark	99	99	65	77	3	63	80
France	99	98	50	69	5	49	62
Hungary	98	91	66	55	52	29	45
Finland	97	94	49	38	11	74	77
Czech Republic	96	97	65	69	24	34	38
Canada	95	98	52	46	9	53	80
Lithuania	88	76	60	38	48	45	37
Bulgaria	87	75	42	22	44	28	21
Japan	75	86	68	27	15	17	9
Russian Federation	42	50	64	45	73	9	14

Table 4 ☐ The data from Table 3 sorted to order countries for programming and e-mail skills

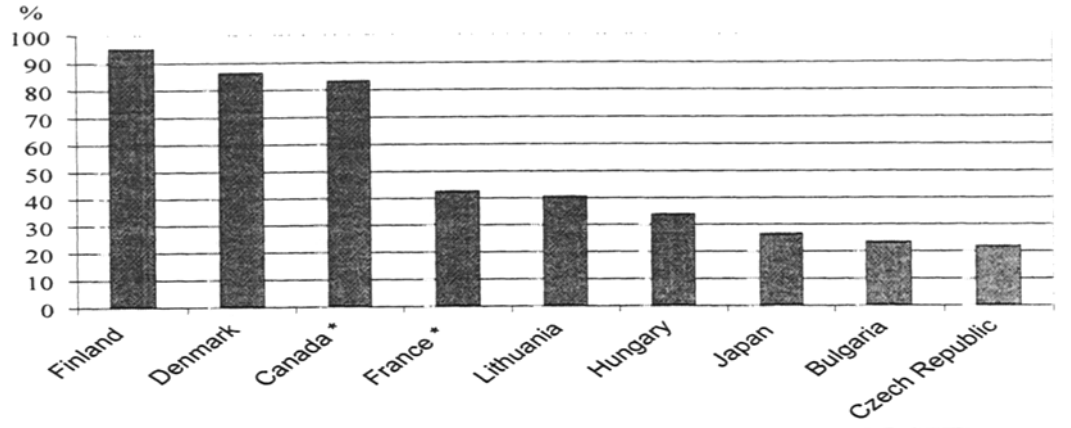
Country	1. *Operate a Computer* %	5. *Write Simple Programs* %	Country	1. *Operate a Computer* %	6. *Communicate via E-mail* %
Russian Federation	42	73	Finland	97	74
Hungary	98	52	Denmark	99	63
Lithuania	88	48	Canada	95	53
Bulgaria	87	44	France	99	49
Czech Republic	96	24	Lithuania	88	45
Japan	75	15	Czech Republic	96	34
Finland	97	11	Hungary	98	29
Canada	95	9	Bulgaria	87	28
France	99	5	Japan	75	17
Denmark	99	3	Russian Federation	42	9

Table 4 shows contrasts between operating a compuer and performing two specific tasks: writing simple programs (programming) and communicating via e-mail (communicating). The relative emphasis on programming in Eastern European countries suggests that the use of ICT is in an earlier stage of development (learning *about* computers) than in Western European countries (learning *with* computers). Japan takes an intermediate position. The differences in respect to the use of e-mail coincide with that observation.

Perceived Opportunities for Using E-mail or the World Wide Web (WWW)

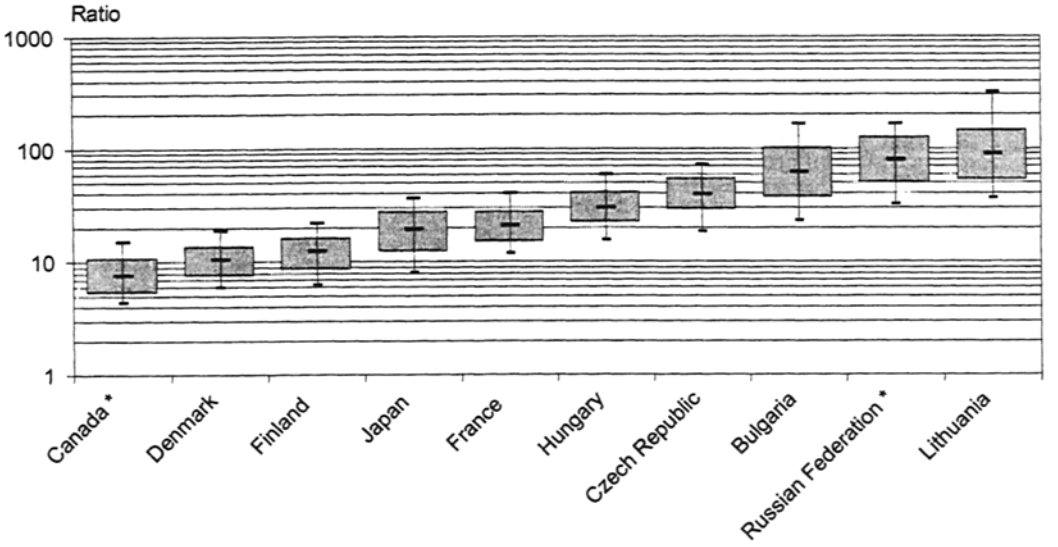
Figure 2 shows the percentages of students whose schools reported that they used e-mail or

Figure 2 ☐ Percentages of students whose schools (technical respondents) indicated that e-mail or the WWW were used, within the grade range, for instructional purposes—lower secondary education



Note: *: country did not satisfy all sampling criteria (see Pelgrum & Anderson, 1999).

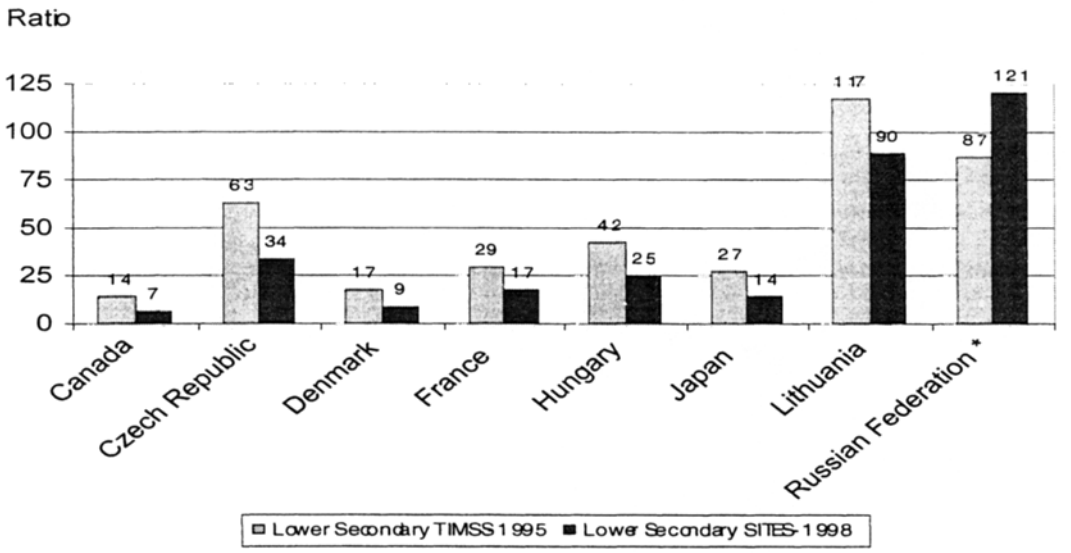
Figure 3 ☐ Box plots of student:computer ratios in computer-using schools—lower secondary education



Notes: *: country did not satisfy all sampling criteria (see Pelgrum & Anderson, 1999). Boxes range from 25% lowest to 75% highest value; the horizontal line in the boxes represents the median; tiles show values for 10% and 90% of the cases. Because of the huge differences between countries, these box plots are presented on a logarithmic scale, the gridlines should be read as 1,2,3,..., 10, 20, 30, ...,100, 200, 300, ...

the WWW for instructional purposes for students at the lower secondary level. The results in Figure 2 show that the countries where lower secondary level students were most likely to be in schools using e-mail or the WWW for instructional purposes (within the grade range) were Canada, Denmark, and Finland. The countries where students at this level were least likely to

Figure 4 ☐ Comparison of student : computer ratios in 1995 and 1998 for lower secondary education (includes all schools: computer-using as well as non-using).



Notes: *: country did not satisfy all sampling criteria (see Pelgrum & Anderson, 1999). Estimates are for all schools, that is, including non-computer using schools.

be in schools using e-mail and the WWW for instructional purposes were Bulgaria and the Czech republic.

Infrastructure

One indicator of the extent to which students can access hardware in a school is the student : computer ratio. This ratio indicates how many students on the average have to share one computer. It can be determined by dividing the total number of students in the school by the total number of computers available.

Figure 3 contains the box plots for the student : computer ratios (calculated on the basis of the above definition) in computer-using schools.

The student : computer ratios at lower secondary schools differed substantially between countries: the medians varied, for instance from nearly 100 in Lithuania to nearly 7 in Canada. Overall, it seems that the countries in Central and Eastern Europe are lagging behind in terms of availability of computer equipment in schools.

Comparison of student : computer ratios between 1995 and 1998

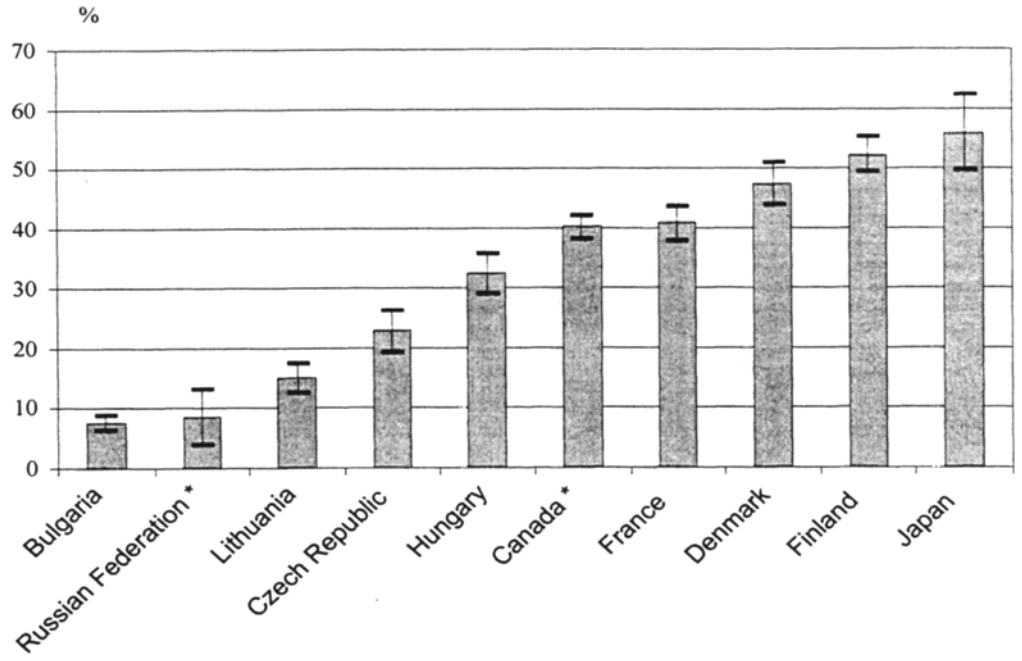
The Third International Mathematics and Science Study was conducted in 1995 and also contained a few questions about the availability of computers (Beaton et al., 1996).

Figure 4 reveals that there was considerable improvement in the student : computer ratio in all countries except the Russian Federation across the intervening three and a half years.

Hardware Functionality

The student : computer ratio, although of interest to policy-makers (given that policy targets in many countries refer to planned ratios), is a rather crude indicator of the available ICT-infrastructure. Also of interest is the potential functionality of the available equipment. From the average percentages of multimedia computers (Figure 5), one may infer that especially the countries in Central and Eastern Europe were, not surprisingly, lagging behind with regard to the availability of this kind of equipment.

Figure 5 ☐ Bars and 95% confidence interval of average percentages of multimedia computers for the grade range in computer-using schools—lower secondary education



Notes: *: country did not satisfy all sampling criteria (see Pelgrum&Anderson, 1999). Top of bar displays 95% confidence interval.

Most Satisfying Experiences with ICT

For this part of SITES Module-1, school principals were asked to give "an example of the most satisfying experience of a learning activity in your school in which students use computer-related technology, which gives students the most useful, effective and advanced learning related experiences with technology." The main reason for including this question was to collect additional information on the emerging paradigm. In this section we will report on the results from lower secondary education of the Eastern European countries on which we report here. When appropriate we will compare the results of these countries with the analysis that was conducted on the examples from lower secondary education that all participating countries provided (Voogt, 1999). Of the countries participating in the study on lower secondary education, 42% of the respondents reported an example. This percentage was considerably lower for the five Eastern European countries. Only 29% of those respondents included an example. For reporting to the international part of the study, countries selected 10 examples per educational level[1]. The 10 examples were selected by excluding examples that were seen as fitting more into the traditionally important paradigm, such as *only* focussing on computer programming or ICT basic skills. Also drill and practice applications were deemed inappropriate as demonstrations of advanced practices. According to the National Research Coordinators the selected examples could be considered to be a representative sample of innovative use of technology in their respective countries. For analyzing the descriptions the categories and keywords as summarized in Table 5 were used.

1 The Russian Federation did not send translated examples for further analysis, so they will be excluded in this section.

Table 5 ☐ Categories and keywords used for the analysis of the descriptions

Categories	*Keywords*
Curriculum domains	math; science; mother tongue; foreign languages; computer literacy or science; social studies; arts; cross curricular; extra curricular; other
Computer-related technology	programming languages; word processing technology; information retrieval technology; communication technology; computer operation; simulation; readsheets; presentation; database design; Microcomputer Based Laboratories; Web page design, drill, and practice software; drawing and graphics; other
Student activities	information processing; production; communication and collaboration; computer programming; basic ICT skills; remediation and practice; other.
Gain for students	increase in motivation, interest, concentration; increase in active participation, creativity; improvement in knowledge, skills; increase in responsibility, self esteem, independence; increase in collaboration; negative impact; other
Change for teachers	change in teaching-learning practice; ICT skills, knowledge; increase in collaboration; other

Curriculum Domains

For lower secondary schools in the Eastern European countries the most satisfying experiences with computer-related technology that passed the selection filter, occurred most frequently in science (25%), foreign languages (21%), and social studies (17%). Thse findings differ somewhat from the whole picture, where mother tongue (17%), social studies (18%), and science (17%) were reported most. Apparently the recent emphasis on foreign language learning is supported by the use of ICT. Computer literacy or science is not mentioned often in Eastern Europe (4%) compared to the whole group of countries (10%).

School principals described their most satisfying experiences with ICT:

Bulgaria: A set of learning activities based on ICT use in the scope of foreign language education, namely: use of multimedia glossaries and dictionnaires in foreign language studies, participation in the French-Bulgarian distance education project VIFAX, contacts realized by students from the schools with students in schools from abroad through E-mail.

Curriculum domains: Foreign language education—French and English

Lithuania: Students participate in the national LOGO project, "My Town and LOGO." Students collect material and create compositions on different topics concerning past and present life in their towns. They use "Logo Writer" and exchange their works with each other by e-mail.

Student activities: Project-based work. Students search for necessary material in the library. They take interviews from persons outside the school, and observe various objects.

Hungary: Improving cognitive skills, working in small groups using computers and students' journal with specific learning activities.

Gains for students: Learning how to learn, they can gain more information, and the chance to complete entrance exams successfully has been increased.

Czech Republic: NGS Kids Network—participation in National Geographics activity: the students worked in a network with other participants around the world on a measuring of acid rain using PC and the Internet.

Change for teachers: The teacher was a coordinator of activities and a consultant in cases of uncertainty.

Computer-Related Technology and Student Activities

Table 6 shows the results of applied technology. The high totals indicate that often more than one application was used. Eastern European countries reported the use of communication software and software for drill and practice most, followed by word processing and software for information retrieval. The latter two were mentioned by all participating countries. However they reported less on drill and practice software and more on other types of software.

The technology applied is clearly related to the kinds of student activities that were reported. Production activities accounted for somewhat more than a quarter (28%) of the stu-

Table 6 ☐ Computer-related technology related to the most satisfying experiences with ICT (in % of total number of software applications)

Computer-related technology	*All countries* %	*Eastern European countries* %
Word processing	19	17
Information retrieval	21	17
Communication	13	21
Presentation, Web design, Drawing and Graphics	20	10
Simulation, Spreadsheets, Database design, Microcomputer Based Laboratories	9	10
Drill and practice software	9	21
Operating system, Programming Languages	4	0
Other	5	5
Number of respondents	387	63

dent activities reported in Eastern Europe and for 35% of the student activities in all countries. This is followed by information-processing activities, communication activities and activities focusing on remediation and practice (each 21%). The other countries also reported strong results on information processing (26%) and communication (17%) but not on remediation and practice activities (only 9%).

Perceived gain for students and change for teachers

All countries as well as Eastern European countries reported strongest results (44% and 49%) for the improvement of knowledge and skills—often related to improvement of ICT knowledge and skills—as the impact of the learning activity on the students involved. This was followed by gains in responsibility, self-esteem, and independence, which are mentioned in 21% of the reported gains by the Eastern European countries and in 17% of the whole group of participating countries. Given the purpose of the question, expressions of negative impact were neither expected nor observed in the examples.

According to school principals, changes in teaching learning practices occurred most frequently. In the Eastern European examples this was reported in 65% of the changes that were mentioned. In all countries this accounted for 50% of the changes. Changes on an increase in ICT skills and knowledge were reported less by Eastern European countries compared to the whole group of countries (15% vs. 22%).

Concluding remarks

The curriculum indicators showed that the countries in Central and Eastern Europe did not differ systematically from countries in other parts of the world with regard to emphasis on traditional or emerging pedagogical paradigms. However, in terms of infrastructure, systematic differences were seen: schools in Central and Eastern European countries tended to have less equipment, which was considerably less technologically advanced than what appeared in other countries. However, between 1995 and 1998 considerable increase of equipment availability was observed, except for schools within the Russian Federation.

The part of the study revealing the most satisfying experiences with ICT showed that in Eastern Europe quite a number of school principals reported on practices that fit into the emerging paradigm as explained in Table 1. Nevertheless, despite the instruction not to select examples of the use of drill and practice software or developing programming skills, these applications were reported frequently by the Eastern European participants in the study.

The emphasis on programming skills and drill and practice may be considered a developmental stage in the introduction of ICT for educational purposes, just as happened earlier in many countries outside central and Eastern Europe (Pelgrum & Plomp, 1993).

A striking result was the emphasis on communication technology in relation to communi-

cation and collaboration activities and foreign language teaching. These findings suggest that the recent emphasis on foreign languages in education in Eastern Europe is facilitated by the use of ICT. □

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The Integration of ICT in Preservice Teacher Education: A Pilot Project at Three Teacher-Training Colleges in St. Petersburg, Moscow, and Amsterdam

by Joke Voogt, Yuri Gorokovatschky, and Natalia Pourycheva

□ The worldwide change toward an information society also affects developments in the Russian Federation. The Russian Ministry of Education, together with two universities for teacher education, wanted to explore how the educational beliefs and didactical repertoire of teacher trainers and prospective teachers need to be changed, and how information and communication technology (ICT) can facilitate these changes. In this realm the Russian-Dutch project, "Innovative Didactics with ICT," has been set up (University of Twente and Herzen State Pedagogical University [UT/TO and HSPU], 1997). Innovative Didactics with ICT is a small-scale pilot project conducted with three faculties of physics in teacher training universities in St. Petersburg and Moscow (Russian Federation) and Amsterdam (Netherlands). The project runs from the fall semester of 1998 until the fall semester of 2000, and is part of the Russian-Dutch Cooperation in Education, a bilateral program of the two Ministries of Education. An important reason for using the physics faculties in the pilot project is the high standard of physics education in the Russian Federation on the one hand, and on the other, the low motivation of secondary school students to become physics teachers, also a major problem in the Netherlands. Therefore, it was thought, that ICT not only could change physics education but also make it more attractive as a long-term career prospect for students.

The main aim of the project is the preparation of preservice physics students for teaching in an information society. Secondly, the project aims at the integration of ICT in physics teaching in secondary school. As part of the project, exemplary curriculum materials were prepared by the staff of the physics departments of the participating teacher education universities. These materials were required to be an integrated part of the student-teacher physics curriculum. Student-teachers taking part in the project are expected, as a result of the project, to develop a small series of lessons in which ICT has been integrated for secondary school pupils. During an internship in secondary schools these lessons will be implemented. Given this model of operation, the project will be described and evaluation results will be reported.

Innovative Didactics and the Potential of ICT

The intention of the project was that the curriculum materials for the student-teachers and for the secondary pupils are featured by innovative didactic approaches and substantial use of ICT (Voogt and Odenthal, 1999; Lockhorst and Van