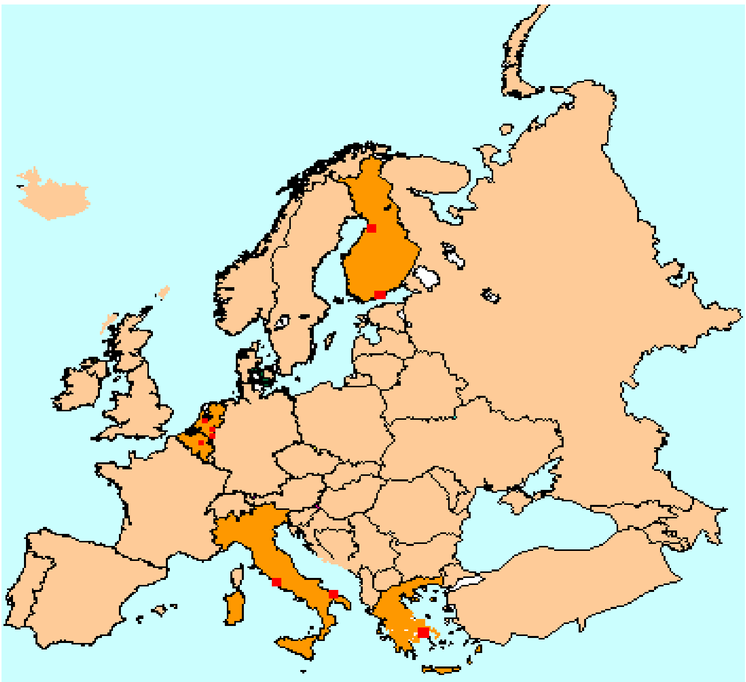
FINAL REPORT

COMPUTER SUPPORTED COLLABORATIVE LEARNING NETWORKS IN PRIMARY AND SECONDARY EDUCATION
Project 2017

HENNY VAN DER MEIJDEN
ROBERT JAN SIMONS
FRANK DE JONG

UNIVERSITY OF NIJMEGEN



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Project coordinator: Prof. Dr. R.J. Simons

Partners:
F. de Jong, (University of Wageningen, Netherlands)
H. Sligte (University of Amsterdam, Netherlands)
E. De Corte, J. Lowijck, L. Verschaffel, (University of Leuven Belgium)
E. Lehtinen (University of Turku, Finland)
K. Hakairainen, (University of Helsinki, Finland)
S.Vosniadou, (University of Athens, Greece)
C. Pontecorvo, (University of Rome, Italy)
A. Baldassarre, University of Bari, Italy)
S. Caravita, (Instituto di Psicologia CNR Rome, Italy):

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COMPUTER-SUPPORTED COLLABORATIVE LEARNING NETWORKS IN PRIMARY AND SECONDARY EDUCATION

H. Van der Meijden, R.J. Simons, F.de Jong (University of Nijmegen)

4. CONCLUSIONS AND POLICY IMPLICATIONS

COMPUTER-SUPPORTED COLLABORATIVE LEARNING NETWORKS IN PRIMARY AND SECONDARY EDUCATION

ABSTRACT:

The central objective of this project was to investigate the cognitive and didactical aspects of computer-supported Collaborative Learning Networks (CLNs). CLNs are learning environments in which educational technology is used to help create *a community of learners who build knowledge together* The central question of the project was: How can effective knowledge building in CLN's be supported in European primary and secondary education? This research was conducted by 11 senior researchers and 15 junior researchers from 5 countries (Belgium, Finland, Greece, Italy, The Netherlands).
Almost 600 students from primary, (age 10-12), secondary (age 13-16) and vocational education (age 18-24), and 25 teachers from 20 schools participated in this project, experimenting with different kinds of software.

Three kinds of measurement instruments were used: 1) protocols of communications between students and between students and teachers have been saved. 2) Tests that measure the cognitive, metacognitive, and motivational effects of CLN's have been used. 3) Small questionnaires and interviews with teachers and students were used to find out which tools, support structures and manuals function the best. In all the case studies conducted during this project, different positive effects were found, but in general, the results obtained in the case studies suggest no robust effects that could be considered as a common finding across the individual projects. Some rather consistent evidence was found suggesting that during the course of the project many students showed less emphasis in superficial engagement and more interest in collaboration. Motivation increased in almost all test sites. Putting together the results from the different test sites wherein cognitive effects were measured and reported, the findings show significant advantages for CSCL classrooms on standardised test scores for curricular domains like language and mathematics, but also on process-oriented measures like quality of question-raising and depth of explanation.

This research shows that it is very hard to realise computer supported collaborative learning (CSCL) in school practice. It is difficult to integrate new didactical practices in existing curricula. Teachers have no time and are not able to design the assignments and questions without extensive support for students that are optimal for CSCL. There are not enough didactical materials nor are there enough good examples available to help them fulfil their new roles. The results of this research highlight the importance of carefully analysing the presuppositions of application of technology-based instructional innovations in practical classroom situations.

On the basis of the experience accumulated so far we propose the following recommendations:1) Support action research on CSCL and facilitate its dissemination. 2) Invest on teacher training for collaborative learning, knowledge building, and conceptual change. 3) Study the processes thereby which self-guided deep inquiry takes place and understand how to guide it in the school environment4) Experiment with innovative curricula that introduce intellectually changeling topics appropriate for deep inquiry and conceptual change. 5) Provide the necessary institutional support for educational innovation. Educate school principals and other school authorities. 6) Facilitate the creation of communities of learners, teachers and parents that are interested in CSCL.

1. EXECUTIVE SUMMARY

Objectives

The central objective of this project was to investigate the cognitive and didactical aspects of computer-supported Collaborative Learning Networks (CLNs). CLNs are learning environments in which educational technology is used to help create *a community of learners who build knowledge together*. CLNs are the learning contexts in which equipment, information networks, but also teacher, learners and learning methods are included. The central question of the project was: How can effective knowledge building in CLNs be supported in European primary and secondary education? The project studied the educational use of different kinds of CLNs that support individual and collaborative learning from a cognitive point of view.

Theoretical background

Nowadays school children and students, who are our future citizens, need to acquire the kinds of learning skills (both the individual and the group learning skills) needed in learning societies and learning organisations. They need to acquire the skills that enable them to cope with information and information overload. They need to acquire skills to build knowledge. The social dimension in the construction and building of knowledge is emphasized in the latest psychological and educational theories. Learning occurs through dialogue rather than primarily through individual learning. Students must learn to build knowledge independently and collaboratively from an early age. The kind of discourse that supports such learning is not discourse in which students display or reproduce what they have learned. It is the kind of discourse that advances knowledge in the sciences and disciplines.

Collaboration between learners has been an educational goal for many decades and has been hard to establish. New developments in information- and communication technology (ICT) make it possible to provide support to teachers and students as they experience new ways of teaching and learning, in particular collaborative learning. By following cognitive principles of learning, technology-enriched learning environments can provide advanced means for the production of knowledge and constructive communication. The passive ways of learning can be transformed into interactive and collaborative learning in (and between) classrooms and between teachers and learners.

Using educational groupware and computer networks creates powerful learning environments. Technology is not used for instructional delivery but as tools that support knowledge construction. In these learning environments facilities are systematically embedded to support learning interaction between students, sharing of cognitive achievements and interaction between students and teachers. Students are encouraged to take responsibility for their own learning. Widening local networks offers the opportunity of breaking the boundaries of the classroom and communication among different learning communities.

Preparing learners for participation in a networked, information society in which knowledge will be the most critical resource for personal, social and economical development, is one of the basic objectives for education today. Computer-supported collaborative learning (CSCL) is considered as one of the most promising innovations to improve teaching and learning with the help of modern information and communication technology (De Corte, 1996; Lehtinen, Hakkarainen & Lipponen, 1998; Verschaffel, Lowyck, De Corte, Dhert & Vandeput, 1998). Collaborative learning refers to an instructional method whereby students are encouraged or required to work together on problem-solving or learning tasks. In its ideal form the collaboration involves the mutual engagement of learners in a coordinated effort to solve a problem together or to acquire together new knowledge (Lehtinen et al., 1998). As such, collaborative learning is a method that is in line with the new conceptions of learning and opposed to the traditional 'direct transmission' model, in which learners are assumed to be passive, receptive, isolated receivers of knowledge and skills delivered by an external source (De Corte, 1996; Verschaffel et al., 1998).

Review of research

Most of the recent research on the use of information and communication technology in education is more or less explicitly considering technology's possibilities to facilitate social interaction between teacher and students and among students. Collaboration and communication is certainly a main idea in network-based learning environments but social interaction has also been more and more taken into consideration in designing and implementation of systems which are running in separate workstations (see several chapters in Vosniadou et al., 1996).

There are two research traditions which have powerfully contributed to the development of the ideas of computer supported collaborative learning. The first source is cooperative learning, which was an important element already in the programmes of progressive pedagogics from the beginning of this century. According to Slavin (1997) research on cooperative learning can be considered as one of the greatest success stories in the history of educational research. The amount and quality of that research greatly accelerated in the early 1970's and is currently one of the most expanding topics in educational research. Numerous studies have compared cooperative learning to traditional teacher centred studies and several theories have been presented to explain the mechanisms behind the observed gains in achievement.

The other source of inspiration for developing computer-supported collaborative learning originates from the research on Computer-Supported Cooperative Work (CSCW). This research has revealed many issues about the cooperative nature of work in computerised work context (Baskerville & Smithson, 1995; Tuomisto, 1994). Some of the theoretical ideas and computer tools used in CSCL environments have originally been created and elaborated in modern work contexts.

In this review the main findings of the cooperative learning tradition that have proved to be important in developing CSCL environments shortly are summarized.

In the studies summarised in Table 1 there are also experiments where computers and networks are used as communication tools in distance and asynchronous interaction (interacting through computers).

Many of the studies are, however, short term experiments focused on a small number of students. Some of the CSCL projects like CoVis project are very widely spread but well controlled follow up results of the methods are still missing. It is also important to notice the general problems impact studies. Learning environment studies with positive effects have much better opportunities to be published than qualitatively equal studies with negative or no significant effects. In addition the so called control conditions are seldom as carefully planned as the experimental treatments (see Kulik & Kulik, 1987). Bearing in mind the above limitations we can infer that it is possible to improve the quality of learning by using CSCL methods.

Authors	Tools	Subject	Participants	Effects

Alavi, M. 1994	Vision Quest´s Software: a tool for teamwork and collab. know. construction (WS)	Information systemsmanage-ment	127 MBA students	Significant experimental effects on subject learning affect. react., perceived skills, self reported learning and interests
Baker, Levy Cohen, & Moeller, 1997	(KidCode) e-mail-based software/ mathematical representation tools (WAN)	Mathematics	20 children (ages 5-10)	Improvement in children's skills/ competence with symbolic processing*
Bell, P. 1997.	(KIE) Internet-based learning suite: argumen-tation tools (WAN)	Physical science	180 middle school students	Progress in use of conceptual model*
Bruckman, & De Bonte, 1997	Text-based virtual reality environment (WS)	Reading, writing and computer-programming	3rd-6th. graders, N=?	positive impact on the atmosphere
Brush, 1997	ILS (Integrated Learning Systems) used by individuals and groups (WS)	mathematics	65 fifth-grade students	Students in groups showed significantly positive attitudes and created higher order questions than individuals
Butler, 1995	Daedalus Mail and InterChange, a conference system (LAN)	History	45 high-school students and peer tutors (university students)	students' learning and their attitudes toward writing and the study of history improved*
Chyung, Repman, & Lan, (1995).	Academic Risk-taking (ART) math computation task (WS)	Mathematics	75 third grade and 62 fourth grade students	CSCL students took significantly higher risks (selected more difficult problems)
Enyedy., Vahey,. & Gifford, 1997	Probability Inquiry Envi-ronment (PIE) (WS)	Mathematics	7th graders (PIE gr. n=45, contr. Gr.=54)	Significant experimental effect on math tasks
Graves, D. & Klawe, M. 1997	A multi-media tool (Builder) for student pairs (WS)	Mathematics	134 element. school children, 10-12 years old	significant experimental effect on math tasks/ positive attitudes
Hmelo, Vanegas, Realff, Bras, Mulholland, Shikano, & Guzdial, (1995).	Collaborative Multimedia Interactive Learning Environment (CaMILE) for Problem Based learning (WAN)	Engineering	engineering students N=?	CSCL students were better at examining the ethical, environmental, and economic issues but not in applying their knowledge*
Hooper, Temiyakarn & Williams, 1993	Computer program designed for experimental purposes	Artificial symbol system	175 fourth-grade students	High and average-ability CSCL were significantly better in higher level learning and generalisation tasks
Kupperman, Wallace, & Bos, 1997	World Wide Web-database (WAN)	Social science	82 high school students,	No anticipated effects
McConnell, D. 1994.	Computer conferencing and electronic mail (Caucus system) (LAN)	Management	2 year part-time university students N=?	Observed effective group dynamic *
Newman, Johnson, Webb & Cochrane (1997)	Network Telepathy computer conferencing system (WAN)	Information management	Undergraduate students	Face-to-face seminars were better for creative problem exploration and computer conferencing for further elaboration and integration
Repman, J. 1993.	Unstructure, structured, structured collaboration with training in computer environment (WS)	Social studies	190 seventh grade students	Significant difference in the quality of thinking in favor of group that received collaboration training
Shabo, Nagel, Guzdial, & Kolodner, 1997	JavaCap, tool for problem-based learning	Earth science/ life science	7 eighth graders, 14 seventh graders	Only process observations: mainly positive effects*
Seymour, 1994	Drawing software	Computer aided drafting	57 university students	No significant differences between cooperative and individualistic structures
Silverman, Barry G. (1995).	Constructivist jigsaw with and without computer support (LAN)	Management	Adult, tertiary students	Computer supported collaboration students outperformed pure collaboration group

Table 1. Effects of recent CSCL experiments

Explications Table 1.

* no controlled experimental model

WAN = wide area network based system

LAN = local area networks based system
WS = a single workstation based system without network

Participants

In total about 20 schools in the different countries participated. Almost 590 students participated in the project, working with different kinds of software. Table 2 gives an overview of the participants (schools and teachers), the used software, the domains involved, and the tests administered in the different countries.

	Belgium	**Finland**		**Greece**	**Italy**	**The Netherlands**		
		Helsinki	**Oulu**		**Bari/Rome**	**Nijmegen**	**Amsterdam**	**Wageningen**
Test site								
schools	1	1	1	1	5	1	3	5
classes	4	1	2	2	8	6	3	groups
level	primary	primary	primary	primary	primary	higher sec.	primary	Second. vocational
students	85	21	56	52	118	142	45	75
age	10-12	10	12		9-12	13-16	10-12	18-24
teachers	4	1	2		6	4	3	5
domains	mathema tics	environ ment	science literature	science	history	biology history science	mathematics	agriculture
Experiments								
within classes	+	+	+	+	+	+	+	+
between classes	+					(1x)	+	
international	+						+	
software	WKF	CSILE	CSILE	WKF	discover/ our world	WKF	WKF	WKF
Measurements								
motivational	+	+	+			+	+	+
cognitive	+	+	+	+	+	+	+	
metacognitive	+	+	+		+	+	+	+
videotaping	+	+	+		+	+		
audiotaping					+	+		
interviews	+	+			+	+	+	+
database	+	+	+	+	+	+	+	+

Table 2: Overview of the activities of the CL net project

Methods

Three kinds of methods were used.

1) Protocols of communications between students and between students and teachers have been saved. Students' productions have been analyzed in terms of the number and kinds of communications taking place. Moreover, qualitative aspects were studied (what kind of inputs were students giving; which thinking types were used; how relevant were communications; how much knowledge building was taking place). Case studies and small-scale, informal comparative experiments were conducted.
2) Tests that measure the cognitive, metacognitive, and motivational effects of CLN's have been used and further developed.
3) Small questionnaires and interviews with teachers and students were used to find out which tools, support structures and manuals function the best and what changes were needed in the materials developed.

Used software

In the CL-Net project, communication is at the core of all software development and use. Dependent upon the very concrete goals and tasks, the software differs as to (a) content, (b) curriculum and (c) target group characteristics. For example, WorkMates has been a common tool for information delivery and communication, used by the research group for exchange of documents and project-bound information. Our World and Discover Your Town/Our Castle are instances of highly content oriented and multimedia software, referring to both different groups of children and specific curriculum content. CSILE and KF are consistent with the notion of ‘co-construction’ of knowledge, using very open software to support cooperation and collaboration in many subject-matter domains, like arithmetic and literacy. The quality of this software highly depends upon the quality of both the information put into the database and the concomitant support offered by teachers and peers.

From the outcomes of descriptive-empirical research, it is evidenced that the different software characteristics influence its use made by youngsters in order to attain specific goals. Consequently, the CL-Net research clearly points to the intrinsic interaction between environmental characteristics (software type) and the activities and processes of users, induced by the software. This interplay between environment, curriculum and learners seems to indicate paramount research questions of the future. Not the isolated characteristics of software, but the way it is embedded in a complex context seems to elicit specific outcomes or effects. Consequently, research on instructional design cannot be restricted to the development of ‘isolated’ software but requires more complex interaction studies.

Measurement instruments

The main aims of evaluation in the CL net project were: evaluation of cognitive, metacognitive and motivational effects of the learning environment, in which educational technology is used to help create a community of learners who build knowledge together. Based on different kinds of software packages, a number of experiments was executed. Different measurements were used in the CL net project to collect data: questionnaires, protocols, videotaping, audio-taping, students’ productions in the databases, and cognitive tests. Table 2 gives an overview of the measurements used in the different countries.

	Belgium	**Finland**		**Greece**	**Italy**	**The Netherlands**		
		Helsinki	**Oulu**		**Bari/Rome**	**Nijmegen**	**Amsterdam**	**Wageningen**
Measurements								
motivational	+	+	+			+	+	+
cognitive	+	+	+	+	+	+	+	
metacognitive	+	+	+		+	+	+	+
videotaping	+	+	+		+	+		
audiotaping					+	+		
interviews	+	+			+	+	+	+
database	+	+	+	+	+	+	+	+

Table 2 Overview measurements

The goal orientation and motivational beliefs questionnaire (all countries)

The item pool to be used as a basis for constructing measurement instruments was based on an integrative account of action-theoretical and goal-theoretical perspectives on motivation (Niemivirta, 1998). An item pool consisting of 67 items was constructed that incorporated various aspects related to student motivation, like: action control, need for cognition, goal,

learning, performance, avoidance orientation, means ends beliefs of effort, ability, luck, agency beliefs of ability, self-assessment motive, self estimation, anxiety, and study habits.
Four sets of items were used for the study:
A shorter and simpler version of the full questionnaire was constructed to be used with the younger pupils from Belgium, The Netherlands, Greece, and Italy (35 items). Two modified questionnaires with some scales excluded and some others added were used for the two projects in Finland. The original full questionnaire with some additional items and modifications was used only with two samples in The Netherlands.

The metacognitive questionnaire (all countries)
To analyse metacognitive effects we used a metacognitive questionnaire based on Ligorio and Caravita questionnaire which has been used in a few previous researches (Caravita & Ligorio 1995, Ligorio & Caravita 1994; Ligorio et al. 1993). It is composed by three open-ended questions at the pre-test and five questions at the post-test. At the pre-test, the questions are very general, in fact the context learning is never specified. The first question inquires pupils' perception of the source of knowledge; the second inquires the criteria pupils use to control the knowledge acquisition process, and the third their perception of the significance of communication and exchange of information in knowledge acquisition

Here below are listed the questions included in the metacognitive questionnaire:

Q 1 - What do you do when you want to know more about something?
Q 2 - How do you know you really understood something?
Q 3 - Do you think it is useful to communicate with others?
Q 4 - What are the most interesting things you learnt this year in History? (Only at the post-test)
Q 5 - What did you do to learn them? (Only at the post-test)

Two additional questions were included at the post-test and closely related to project contents. Both at the pre and post-test the questionnaires were administrated by a researcher. The questionnaire was always passed during the school hours. Teachers were asked not to intervene during the whole administration session. No time constrain was given and it was stressed to the students that there was no right or wrong answer and that they were required to answer with their own thoughts. Also they were insured that their answers to the questionnaire would not affect at all their school grades. The average time needed to complete the questionnaire was around 30 minutes. When required, the researcher supplied additional instruction to the students in order to help them filling in the questionnaire.
The idea behind these questions and the accompanying scoring system was that CSCL environments like the ones designed and implemented in the different CL-Net sites, would result in a change in pupils' metacognitive and epistemic beliefs from external or internal into interactive. This questionnaire was simplified by the Amsterdam researchers for primary school children.

Classroom observations and interviews
In order to envisage the emergence of collaborative attitudes, such as expressing interest for peers work and thinking by reading messages, asking for opinions, and of collaborative actions, such as reacting to messages, making proposals to share projects, working on other classes ideas, integrating outcomes, observations were carried out in different manners:

- field-notes and audiotapes
- field-notes and video-tapes
- audiotapes of class discussions

Documentation was integrated with:

- initial interviews with principals for a description of the test-sites (Italy)
- interviews with students about the program
- interviews with teachers about collaborative work before the start of the project (some countries) and at the end of the project (all countries)

Contributions in the database
Protocols of communication s between students have been saved.All students' contributions were collected. In most countries all 'pupil notes' were submitted to a quantitative analysis at the end of the project (how many notes, what length, how many notes read from other pupils). This was followed by a qualitative analysis, in which the content of students' notes was analysed.

Cognitive test
The cognitive effects have been studied mainly using two different kinds of data. Some research teams have studied cognitive effects by looking at the development in the nature of the cognitive exchanges that take place in the computer-supported collaborative learning environment in general. A second manner in which cognitive effects have been investigated in the CL-Net project is by comparing students' performances and solution processes on pre-tests and post-tests dealing with the concepts, techniques, cognitive strategies etc. that constitute the domain-specific content of the lessons for which the CSCL environment was developed. Not all descriptions of the work done in the different test sites contain a report of the cognitive effects.

Effects

The main aims of evaluation in the CL net project were: evaluation of cognitive, metacognitive and motivational effects of the learning environment, in which educational technology was used to help create a community of learners who build knowledge together. Based on different kinds of software packages, a number of experiments was executed. Different measurements were used in the CL net project to collect data: questionnaires, protocols, videotaping, audio-taping, students' productions in the databases, and cognitive tests.

Cognitive effects
Because different subject-matter domains and different age levels were involved in the distinct test sites, it was impossible to develop a general instrument that would be used in the different test sites involving different curricular topics (biology, phyisics, environmental studies, history, mathematics…) and pupils of different ages. This makes an overview of the cognitive effects somewhat more problematic than for the other kinds of student effects reported in this section of the final report. Moreover, because the focus of the CL-Net project was on metacognitive and affective effects of CSCL on students, not all descriptions of the work done in the different test sites contain a report of the cognitive effects.
The cognitive effects have been studied mainly using two different kinds of data. Some research teams have studied cognitive effects by looking at the development in the nature of the cognitive exchanges that take place in the computer-supported collaborative learning environment in general. This kind of data has been used as evidence of cognitive effects only if the data-analysis has been done in such a way that (a) it reveals something about the quality of the domain-specific knowledge or skills being demonstrated in the CSCL environment in comparison to other, non CSCL environments, or (b) it describes how the quality of the

domain-specific concepts and skills demonstrated in these computer-supported interactions evolved throughout the intervention. A second manner in which cognitive effects have been investigated in the CL-Net project is by comparing students' performances and solution processes on pre-tests and post-tests dealing with the concepts, techniques, cognitive strategies etc. that constitute the domain-specific content of the lessons for which the CSCL environment was developed.

Putting together the results from the different test sites wherein cognitive effects were measured and reported, the findings seem to confirm the results of the evaluation studies comparing CSILE and non-CSILE classrooms (Scardamalia & Bereiter, 1998) showing significant advantages for CSILE classrooms on standardised test scores for curricular domains like language and mathematics, but also on process-oriented measures like quality of question-raising and depth of explanation. The important additional finding provided by the CL-Net project is that these positive cognitive effects can also be obtained in non-laboratory settings or at least in settings that are representative for the 'habitat' of most European teachers and pupils in the late nineties.

However, it should be acknowledged that the cognitive effects obtained in the CL-Net project are rather small. Moreover, the positive conclusions with respect to the cognitive effects drawn at the end of some case studies are sometimes jeopardised by a number of methodological problems. Nevertheless we consider them as additional evidence that it is possible and feasible to significantly contribute to upper elementary and lower secondary school pupils' conceptual and cognitive development by means of CSCL systems, even in settings where the technology-based support is still rather small and where teachers and pupils are relatively unfamiliar with systems for CSCL like KF and with the constructivist learning pedagogy underlying them.

Metacognitive effects

In this project metacognition is considered as an additional layer supporting the development of a community where knowledge construction is considered as a social process. All the available tools, including teachers, technology, as well as the intervention of the researchers, are intended to foster higher order thinking abilities (Brown & Campione 1994; Campione et al. 1992, Pontecorvo 1990; Scardamalia & Bereiter, 1993). In this project metacognition is specifically viewed as students’ awareness of the learning process, composed by:

a) inquiring sources considered as knowledge “container”,

b) monitoring the comprehension, the achievement of the learning process

c) the perception of communication as a further learning process .

All the countries involved in the CL -Net project share a similar distribution of the variables observed at the pre-test. That is:

- the sources used to improve the knowledge are mainly internal
- the knowledge monitoring tends to be either internal or external
- the communication in prevalence perceived as a social process, useful to exchange information and to establish relationships.

Although differences in terms on each variable are observed, at the end of the project the communication perception changed in most of the sites. This result suggest that the communication perception is the most sensitive variable to be impacted by a project like this. Also we learn from the Nijmegen case that pupils relate the communication process more to the out-side class. This could be an additional explanation to the higher impact on this variable. About the different impact on the other variables some conclusion can be taken based on the national cases reported.

In order to improve metacognitive skills, it may be not enough to introduce a computer-supported learning environment. The nature of the issues introduced should change as well, in a way that may be more sensitive to innovation. In fact, in Italy a difference between traditional and innovative, multidisciplinary curricula has been experienced.

More traditional learning environments may impact in a different degree depending on the gender of the pupils. In fact, in Greece boys were able to change their attitude towards the knowledge sources while girls change more their style of knowledge monitoring.
Also, in order to have better cross-national comparison, it is recommended, in further European projects, to better standardize the translation and adaptation of the tools, to agree on a common decoding system, and to use similar statistical test for the analysis of the data.

Motivational effects

The item pool (67 item questionnaire) used as a basis for constructing measurement instruments was based on an integrative account of action-theoretical and goal-theoretical perspectives on motivation. The core idea of this framework is that students' activity in a learning situation is guided, supported, *and* constraint by their goals, beliefs, and expectations about one's ability to control and to successfully execute actions and to thereby influence the environment (Mischel, Cantor & Feldman, 1996).
Furthermore, it is argued that students can be characterized in terms of their predominant motivational orientations and the distinctive organization of the interrelations among them and the psychological features of the situations (cf. Boekaerts & Niemivirta, 2000).
The main aim of the present project was to conduct a basic descriptive analysis of the individual differences in motivation within and between the participating countries. Accordingly, we sought to (1) examine the evolution of pupils' self-reported motivational dispositions in the course of each project, and (2) explore some possible motivational trends and patterns of differences (or similarities) among the participating countries. Due to the overall nature and characteristics of the project (e.g., relatively short time span, implementation in a "real world" setting) "true" experimental designs were not possible to employ. Because of this, each site specified their own research aims and focused on aspects relevant to their particular project. Therefore, no overall assumptions were made with regard to changes over time or differences between groups. However, we believed that the results would (1) help us to distinguish groups of students in terms of the mind frame with which they approach school work in general, and thus (2) provide a frame of reference against which to interpret site-related findings between and within the participating countries.
In all case studies, the questionnaires were submitted both at the starting point and at the end of the project. Although the procedure for the assessment had been established for all the research groups, some disparities were still found in the way each sub-project carried out the survey. These differences were mainly due to the varying conditions in each test-site.
In general, the results obtained in the case studies suggest no robust effects that could be considered as a common finding across the individual projects. Two reasons could explain the fact that not many changes were found in the first place: either there genuinely were no changes or the measurements themselves were not sensitive enough to capture them. Indeed, considering the time span of each project the methods applied might have not tapped the most appropriate level of measurement. However, as pointed out in the beginning, the main focus here was to provide descriptive information to be utilised in further stages of analysis. Despite these methodological concerns, some rather consistent evidence were nevertheless found suggesting that during the course of the project many students showed less emphasis in

superficial engagement and more interest in collaboration. This possibility alone can be considered as an encouraging outcome.
The purpose of the comparative analysis is to provide an overview of the cross-cultural differences (or similarities) found in motivational measures. The goal was *not* to consider any motivational "effects" *per s*e, but to rather explore the possibility of some general trends (e.g., degree of stability and change) in pupils' motivational scores across the groups and over time. Few cautious conclusions can be drawn. First, however, it must be emphasised that the scope of inquiry was rather limited. Only few samples and a very restricted set of items was included, thus leading to a rather narrow conceptual breadth. Nevertheless, some noteworthy results were found. The stability of measurements at the group-level was surprisingly high. Both construct mean levels and mutual differences between the samples remained rather similar over time. Despite some psychometric problems resulting from the administrative procedures, it still can be stated that at least some of constructs included in the present project seems to "exist" and operate in similar ways across the participating countries. Further, a clear trend in mean differences was found that might reflect true cultural variations both in pupils' motivational beliefs and in their response styles. In general, it seemed that the southern participants, i.e., Italian and Greek pupils, were more inclined to a bold and acquiescent response style that resulted in systematic group-level differences. Since these measurements were not related to any other measurements, it remains to be seen whether the within-group differences operate in a similar fashion in all samples. Also, for the same reason, nothing can be said about the potential significance of the group-level differences.

Collaboration and communication between peers

In the great majority of the case studies, collaboration between students was enhanced not only through communication at a distance, but also in dyads, small groups, and class-groups interactions. Children worked in pairs at the computer, not for a lack of technological resources, but for a precise educational choice: stimulating children to discuss and interacting to each other, making explicit their thinking that sometimes generated productive cognitive conflicts. In the most of the experiments, dyads or small groups of pupils were considered as the unit of action and communication, also in the case of communication at a distance. It was also given some time for group activities (in Greece, in one of the Wageningen experiments, in Nijmegen, in the two Italian case studies) and for class-group discussions (Greece, Belgium, and Italy).
As reported in the various case-studies communication is achieved in all test-sites, while collaboration for knowledge building was not realised in all cases. This is due to the variety of contextual influences in the various countries and regions. Among them are the specific socio-economic, cultural and historical factors that have 'shaped' educational activities and systems to what they are at present. The in-class experiments can be seen as an extension of 'normal' lessons, but when the computer is used for in-class communication some artificiality is sensed by the actors involved. Although the computer is a known seducer, its usage may distract from the task-oriented character of building knowledge together.
The out-class experiments are evidently more difficult to organise, but trigger more motivation. In various cases the pupils were highly motivated in receiving or sending messages to distant schools, with the impression that when the partners are more distant the more thrilling it was experienced. The teachers got more motivated in the use of the electronic communication because they saw their pupils to be enthusiastic about it. But to start a collaboration for knowledge building implies conditions that go far beyond motivation to communicate. Good preparation among the teachers involved, respecting and creating 'golden rules' for communication and collaboration, monitoring and participating actively in the

computer-supported interactions, enhancing the teachers' competences both regarding their pedagogic-didactic repertoire in general, their ability to offer scaffolds for learning, and an orientation for innovation, belong to the conditions to be satisfied if computer-supported collaborative learning is to conquer a place in temporary European classrooms. Further research into these conditions will be necessary.
The international collaborative projects are a more specific elaboration of out-class computer-supported collaborative work and learning. As said, the motivation for active participation is likely to be higher, but the contextual conditions are more difficult to be satisfied. Language- and culture-related issues can pose insurmountable problems. One of the ways to overcome them is to define these problems as challenges for learning: differences in language can constitute learning goals as well in addition to task-oriented collaboration.

Collaboration between teachers and researcher

The CL-Net first puts a great stress on collaboration between teachers and between teachers and researchers. In at least two of the case studies, one of the aims of the research was to create a community between teachers and researchers (see *Our world* and *Discover your town* case studies). In those two projects a lot of effort was spent in order to let teacher communicate to each other. Several meetings were organized to give an opportunity to discuss problems and feelings and to found commonalties among the different schools partners involved. It was also implemented a forum for communication at a distance. In the majority of the other case studies collaboration between teachers was also an important point of the research. In fact: in The Netherlands the outlines of the different study projects were developed by the teachers in co-operation with the researchers, in Belgium teachers had several meetings with researchers and they experimented collaboration at a distance supported by a Knowledge Forum (KF) database. The KF database was intensively used and it consisted of three main parts: (a) a general background of information, (b) a discussion forum, (c) a hotline for practical arrangements (see Belgium case study). In Finland teachers and researchers planned collaboratively the learning projects, in Greece, during the second experiment, weekly meetings between teachers and researchers took place, aimed at co-designing and discussing the experiment its-self. In addition, one international meeting was held in Rome, with the participation of researchers and teachers of all the countries involved in the project.

Teachers' role

Introducing CSCL into classroom teaching requires a great deal of teacher support. As has been pointed out before, the task of a teacher is complemented with new competencies, like information-management, time-management and group-management. The teacher must design the curriculum and monitor and manage its progress. Moreover he has to monitor the database and assess the depth of investigation that goes on. CSCL requires teachers' ability in helping learners to follow their own learning route, to offer just-in-time feedback on their knowledge construction, and to scaffold them when they encounter difficulties as novices in many fields, like searching, selecting, processing and reporting information, working adequately in groups, and (co)-constructing meaningful knowledge.

Technical support is also indispensable. Manuals on how to use the different software, training, technical support in case of a computer breakdown, guidelines for using the database for analysing the interaction (like Analytic Toolkit for Knowledge Forum), all kinds of support are necessary. Researchers of the CL net project have provided both pedagogical as technical support.

Collaboration between the teachers involved in the same project, working with the same software, is of great importance, teachers supporting teachers. Meetings between teachers (international, national, local and school meetings) give an opportunity to discuss problems and feelings, to meet partners and find commonalties, to involve more teachers into the project and to foster the perception of the role as researcher.
Financial support, for example computer equipment or extra hours for the teachers is desirable too, as well as support from the administration of different institutions.

Introduction in schools

Our studies indicate that the introduction of computers itself affects the nature of the whole learning environment. These effects, which we call "first-order" effects of educational technology, refer to learning of skills of using information technology, developing skills of basic knowledge acquisition, generally increased motivation, and accessing extended sources of information. First order effects also involve changes in structures of classroom activities and changed division of cognitive labour between the teacher and the students.
It seems that the first-order effects are normal consequences of engagement with computer supported collaborative learning. However, they do not, as such, facilitate social construction of knowledge and advancement of the students' deeper, principled and conceptual understanding, which depends critically on the appropriate supportive activities of teachers, especially their involvement in new roles. Thus a very critical aspect of facilitating pedagogically meaningful use of ICT and practices of CSCL is training of teachers.
The present study does not indicate that students achieved higher-level processes of collaboration but, the practices of learning and instruction changed considerably, representing a significant improvement over traditional practices of learning and instruction. Students were working in a more self-regulated way, directing their own projects instead of following detailed assignments of the teachers, and the amount and quality of social interaction among students and between teachers and students increased. Further, students learned skills of using information technology, developed skills of basic knowledge acquisition, learned access extended sources of information, and in general their motivation increased.
However, bringing computers into the classroom does not automatically lead to what we call second-order effects of educational technology. The second-order effects involve engaging students in a sustained question- and explanation-driven inquiry, true knowledge building, and progressive discourse analogous to scientific practice. The second-order effects may lead to a profound change in the students' conceptions of what learning and knowledge are all about, and they need strong pedagogical support from the teacher. The second-order effects appear, further, to require deep change in teachers' conceptions of knowledge and in the pedagogical practices of school generally. This appears to be very difficult to achieve. Perhaps the theoretical and practical principles of CSCL are still too recently articulated to be widely recognized and applied in practical educational reforms. In order to facilitate CSCL in elementary and secondary level education, a substantial change in pedagogical practices and in the wider culture of schooling is needed. Nevertheless, the culture of school learning cannot be expected to change immediately but presupposes a long process of exploring and testing different cognitive and pedagogical practices.

Conclusions:

Referring to the main goals of the project we can state that all objectives have been achieved:

- Existing research on computer supported collaborative learning that aims to stimulate knowledge building (deliverable: Computer Supported Collaborative Learning, a Review, Lehtinen et al.) was synthesised.
- Ways were found to introduce CSCL in schools. Didactical models, design principles and learning scenario's for the use of CLNs in primary and secondary education were developed (deliverable: A Starters Kit for Teachers ,Verschaffel et al.) and a description of software used in the project (Deliverable: description of software used in the CL-Net, Dhert et al.)
- All countries experimented with different kinds of CLN-tools which support the learning process and the acquisition of knowledge building skills.
- Cognitive, metacognitive, motivational and social effects of collaborative learning supported by computers were evaluated.
- One cross-national experiment between schools in Belgium and The Netherlands was conducted.

Our review of the research literature shows that co-operative learning is effective if: students have common goals / interests combined with individual accountability. It also shows that it is very hard to realise co-operative learning in school practice. Descriptive research shows furthermore, that it hardly occurs in regular practice.

According to our analyses CSCL is closely related to the recent development in theories of learning and instruction and for many researcher some kind of CSCL application seems to be the most promising way to put forward desired changes in educational practice. It became clear that working with CSCL demands a certain educational philosophy from teachers and a certain new role from students.

The educational philosophy focuses on knowledge building instead of knowledge reproduction as the main learning activity. This means believing in and trusting on active, self-regulated, constructive and contextualized learning by groups of students more or less independently. In introducing the software in schools it became clear that we were introducing three innovations at the same time: the didactics of collaborative and co-operative learning; learning with computers and inquiry learning / knowledge building. Moreover, there were two curricula at the same time: the regular one and the one introduced by the program.

It is not so easy to integrate new didactical practices in existing curricula. Teachers have no time and are not able to design the assignments and questions without extensive support for students that are optimal for CSCL. There are not enough didactical materials nor are there enough good examples available to help them fulfil their new roles.

Although the scientific community has considered the principles of CSCL highly promising for the development of future learning environments, this is not yet the case among practicing teachers. For example in recent large survey studies Finnish teachers didn't regard collaborative learning as an important application of computers (Hakkarainen et al., 1998). This result is certainly partly due to the novelty of the CSCL ideas in schools but it also indicates that the theoretical and practical principles of CSCL are still too immature to be widely applied in practical educational reforms. There is a need for theoretically well grounded development of CSCL practices and tools which are adequately embedded in practical educational context. The results of previous research also highlight the importance of carefully analysing the presuppositions of application of technology-based instructional innovations in practical classroom situations.

The development of network technology and software is very fast. This development opens new opportunities to create powerful CSCL environments. Something which has so far been possible only in special local area client-server –systems can now be implemented in the open architecture of World Wide Web. The multimedia elements added in network applications make them very attractive. It is not however self evident if these new tools have also pedagogical value without carefully planned instructional strategies and adequately educated teachers.

2. BACKGROUND AND OBJECTIVES OF THE PROJECT

Objectives

The central objective of this project was to investigate the cognitive and didactical aspects of computer-supported Collaborative Learning Networks (CLNs). CLNs are learning environments in which educational technology is used to help create *a community of learners who build knowledge together*. CLNs are the learning contexts in which equipment, information networks, but also teacher, learners and learning methods are included. The central question of the project was: How can effective knowledge building in CLNs be supported in European primary and secondary education? The project studied the educational use of different kinds of CLNs that support individual and collaborative learning from a cognitive point of view.

The main goals of the project were:

1. To synthesize existing research on computer supported collaborative learning that aims to stimulate knowledge building
2. To find effective ways to introduce collaborative learning networks in schools
3. To develop didactical models, design principles and learning scenario's for the use of CLNs in primary and secondary education;
4. To experiment with different kinds of CLN-tools which support the learning process and the acquisition of knowledge building skills;
5. To evaluate the (meta)cognitive, motivational and social effects of collaborative learning, supported by computer networks.
6. To experiment with cross-national communication between schools.

The research was characterized as ecologically valid action research. Action research is an approach to research in which teachers and students in their everyday context play an important role. Researchers “act as participants” in the schools while collecting data. Teachers and students become researchers and research-assistants instead of subjects of research in the traditional sense. They experiment and try to find the best ways to pose questions, to bring in materialized, to connect students with each other, to provide help, etc.

2.1 SOCIETAL REASONS AND LEARNING THEORIES BEHIND COMPUTER SUPPORTED COLLABORATIVE LEARNING

P. Robert-Jan Simons

Introduction

This chapter describes some of the societal and psychological backgrounds of computer supported collaborative learning in schools(cscl). They are dealing with learning societies and learning organisations as well as with new theories about learning. Two more specific and detailed backgrounds are the concept of knowledge building and social psychological and developmental theories behind collaborative learning in general.

The learning society and learning organisations

European society is increasingly dependent on information and knowledge and needs to keep up with and anticipate to global developments. Some countries therefore aim to develop in the direction of a learning society. According to Sir Christopher Ball, Director of Learning at the Royal Society of Arts in the UK, a learning society involves the following major characteristics:

- learning is accepted as a continuous activity throughout life;
- learners assume responsibility for their own progress;
- assessment is designed to confirm progress rather than to sanction failure;
- personal competence and shared values and team spirit are recognized equally with the pursuit of knowledge;
- learning is a partnership between students, teachers, parents, employers, and the community working together.

Apart from the ideal of a learning society, more and more companies and public organisations are striving to become learning organisations. There are five different reasons why this is the case. Changes have become the rule and stability is the exception. Thus, organisations should be able to change continuously. Because the environment is changing so quickly organisations should adapt. Instead of adapting like plants, however, they should adapt like brains. This means that instead of having one long-term organizational strategy, mission or goal, they should become able to deal with change. Organisations that can change quickly will survive. Human resources become the key resources of an organisation. Its human capital is its main asset and it should be used optimally. Especially, it is important that the human capital is expanded continuously. Through learning the human capital can grow. Strategically, this is also important for the position on the labour market. Talented people like to work in an environment providing opportunities for learning. So they will join learning organisations and stay there. Finally, learning organisations take care of group learning. Therefore, there is less risk that know- how disappears when people leave the organisation.

A learning organisation, thus, is an organisation that is able to change quickly. This means that the people forming the organisation are able to change and learn quickly, both collectively and individually. A learning organisations can be defined as: “An organisation that aims to extend and to relate the learning and learning abilities of individuals, groups and the organisation as a whole in order to change continuously at all three levels in the direction of existing and possible wishes and needs of customers” (Simons, 1995).

Senge (1990) proposed five characteristics of individual learning ability for learning organisations:

1.Personal mastery: Employees should have a goal-directedness in their work and life and should be ready to learn and develop (as a professional).

2.Shared vision: employees should be able and ready to share the organisational vision. They should be and feel involved in organisational goal(s) subscribed by all.
3.Team learning: employees should be able to learn in teams and as teams.
4.Mental models: people should be able and ready to make unspoken assumptions and norms public and available for others.
5.System thinking: people should be able and ready to think in wholes and in relations by reflecting on the system and all its subsystems. When learning and thinking they should consider the consequences for the whole system.

What do the developments in the direction of learning societies and learning organisations mean for students and teachers in the school system?

Nowadays school children and students, who are our future citizens, need to acquire the kinds of learning skills (both the individual and the group learning skills) needed in learning societies and learning organisations. They need to acquire the skills that enable them to cope with information and information overload. They need to acquire skills to build knowledge. The social dimension in the construction and building of knowledge is emphasized in the latest psychological and educational theories. Learning occurs through dialogue rather than primarily through individual learning. Students must learn to build knowledge independently and collaboratively from an early age. The kind of discourse that supports such learning is not discourse in which students display or reproduce what they have learned. It is the kind of discourse that advances knowledge in the sciences and disciplines
Collaboration between learners has been an educational goal for many decades and has been hard to establish. New developments in information- and communication technology (ICT) make it possible to provide support to teachers and students as they experience new ways of teaching and learning, in particular collaborative learning. By following cognitive principles of learning, technology-enriched learning environments can provide advanced means for the production of knowledge and constructive communication. The passive ways of learning can be transformed into interactive and collaborative learning in (and between) classrooms and between teachers and learners.
Using educational groupware and computer networks creates powerful learning environments. Technology is not used for instructional delivery but as tools that support knowledge construction. In these learning environments facilities are systematically embedded to support learning interaction between students, sharing of cognitive achievements and interaction between students and teachers. Students are encouraged to take responsibility for their own learning. Widening local networks offers the opportunity of breaking the boundaries of the classroom and communication among different learning communities.
Preparing learners for participation in a networked, information society in which knowledge will be the most critical resource for personal, social and economical development, is one of the basic objectives for education today. Computer-supported collaborative learning (CSCL) is considered as one of the most promising innovations to improve teaching and learning with the help of modern information and communication technology (De Corte, 1996; Lehtinen, Hakkarainen & Lipponen, 1998; Verschaffel, Lowyck, De Corte, Dhert & Vandeput, 1998). Collaborative learning refers to an instructional method whereby students are encouraged or required to work together on problem-solving or learning tasks. In its ideal form the collaboration involves the mutual engagement of learners in a coordinated effort to solve a problem together or to acquire together new knowledge (Lehtinen et al., 1998). As such, collaborative learning is a method that is in line with the new conceptions of learning and opposed to the traditional ‘direct transmission’ model, in which learners are assumed to be

passive, receptive, isolated receivers of knowledge and skills delivered by an external source (De Corte, 1996; Verschaffel et al., 1998).
As argued by De Corte (1996), Lehtinen et al. (1998), Verschaffel et al. (1998) and many others, appropriate application of the available information and communication technology can significantly contribute to 'strengthen' the power of the collaborative learning environments described above. More specifically, CSCL environments that apply technologically sophisticated tools and that are designed according to principles of powerful learning environments, can provide advanced stimuli and support for a distributed process of inquiry and can - in doing so - facilitate the acquisition of (a) a well-organized and flexibly accessible domain-specific knowledge base, (b) heuristic strategies for problem analysis and problem transformation, (c) metacognitive knowledge and self-regulating skills, and (d) positive beliefs, attitudes, and emotions related to problem solving and learning and the areas on which these problem-solving and learning skills are applied.

A new theory of learning

The developments in society and in organisations ask for new kinds of skills that should at least partly be prepared in schools. New learning outcomes as described by politicians, parents, teachers and company representatives refer to outcomes that are *durable, flexible, functional, meaningful, generalizable* and *application-oriented* (see also Engeström, 1994; Lodewijks, 1993). They should be *durable* in the sense that they remain over a long period of time. Instead of learning for today and tomorrow people should be learning for months, years or even lifetime. Learning outcomes should be *flexible* in that they can be approached from different angles and perspectives instead of being tight to one perspective rigidly. Results of learning should be adaptable to new contexts and changes in contexts. This can only happen when there is deep understanding instead of rote learning. Flexibility relates to internal relational networks between knowledge elements that are approachable in an easy way. The *functionality* of learning outcomes refers to their "just in time, just in place" character: the results of learning should come to the fore at the right time and place. People should learn what they need at a certain time and place, not less not more. (Mellander, 1993). Learning outcomes should also be *meaningful*: real understanding of a few basic principles with far-reaching importance for understanding is more important than superficial understanding of many facts that become obsolete anyhow. Learning outcomes should be *generalizable* in the sense that they are not restricted to one context or situation but reach out to other contexts and situations. Finally, learning outcomes should be *application-oriented*: people should know the possible applications and their conditions of use: when and where is application of the learning possible or necessary.
Furthermore, we need new *kinds* of learning outcomes: learning-, thinking-, collaboration and regulation-skills. Where the previously described characteristics all relate to the transferability of rather traditional knowledge oriented learning outcomes, these ones refer to skills that can be applied on information and on learning processes. These kinds of skills will be needed because of the information overflow and the exponential increase of information. It will be impossible and unwise to focus on "taking in as much information as possible". Instead, a focus on the skills of learning, thinking, collaboration and regulation should prevail. It is more what people can do with information than the information itself that becomes important. Finding one's way in the growing body of knowledge becomes more important than having many factual details in memory.
What kinds of new learning processes are needed in order to reach the new outcomes described above? In our view there are three different ways to learn: guided learning, experiential learning and action learning. They differ in many respects from each other and they produce slightly different kinds of understandings.

In organizing guided learning there is a guide, an expert who knows the way and who plans the learning. The guide determines the contents and acts as the decision-maker. He decides about the goals of learning, the learning strategies, the way to measure learning outcomes and he takes care of feedback, judgment and rewards. The learners should commit themselves to the decisions made and should follow and obey the trainer or teacher.

In experiential learning it is not so much a leader or even a predetermined goal that controls the learning. It is like a trekking journey where a group of people undertakes a trip without planning and organizing at forehand. One might think of a group of (young) people with their back-bags, walking or biking together. They just go away on a certain date without any concrete destination planned. They just go where they agree to go and let their plans develop underway, depending on the circumstances like the weather, the people they meet, their feelings and so on. Circumstances, personal motivation, other people, innovations, discoveries, experiments etc. determine what and how one learns. There is not even an explicit set of learning goals. Instead, learning is a side effect of the activities one undertakes.

In the third way of learning, action learning (Revans, 1982), there is a much more active and explicit role for learners and learning goals than in experiential learning. Learning is central and not a side-effect, but the learners themselves determine the goals of learning according to needs arising in their actions (at work or elsewhere). Learning is not pre-organized and preplanned by an outsider or expert, nor is it depending on coincidental intrinsic motivations. It is self-organized and self-planned. Learners determine furthermore their own ways of self-testing. Reflection plays an important role in finding out what was learned and what should still be learned. Thus instead of letting the teachers or trainers decide about the learning goals, learning strategies and testing, these factors become not unplanned and unorganised as in trekking, but learners decide on their own, and they do this explicitly.

In order to be able to reach the new learning outcomes mentioned above, new kinds of learning processes and strategies are needed. We will discuss twelve characteristics of these new kinds of learning *processes and strategies* as proposed in the literature. Ideal learning processes and strategies, as described in the literature about constructivism, in the psychology of learning and in theories about powerful learning environments, are the active, cumulative, constructive, goal-directed, diagnostic, reflective, discovery oriented, contextual, problem oriented, case based, social and intrinsically motivated kinds of learning.

The first group of six characteristics involves a shift towards action learning and the second group towards experiential learning (see Table1). The first shift from guided learning towards action learning involves an increased activity of the learner in making decisions about learning independently. The shift from guided learning to experiential learning involves increased activity of the learner in a second sense of the term: undergoing important personal experiences, actively thinking, solving problems, finding out things, thinking about concrete cases and learning intrinsically.

Shift towards action learning	Shift towards experiential learning
More active learning	More discovery oriented learning
	More contextual learning
More cumulative learning	More problem oriented learning
More constructive learning	More case based learning
	More social learning
problem oriented	More intrinsically motivated learning
More goal-directed learning	
More diagnostic learning	
More reflective learning	

Table 1: Overview of 12 kinds of new learning processes and strategies in relation to the three ways to learn.

Shifts towards action learning

Shuell (1988) formulated the main characteristics of good learning: "....(constructive) learning is an active, constructive, cumulative and goal directed process.... It is active in that the student must do certain things while processing incoming information in order to learn the material in a meaningful manner. It is constructive in that new information must be elaborated and related to other information in order for the student to retain simple information and to understand complex material. It is cumulative in that all new learning builds upon and/or utilizes the learner's prior knowledge in ways that determine what and how much is learned. It is goal oriented in that learning is most likely to be successful if the learner is aware of the goal (at least in a general sense) toward which he or she is working and possesses expectations that are appropriate for attaining the desired outcome."(p277-278).
Two further characteristics of new learning are, in our view, that it is diagnostic and reflective (Simons, 1997). This means that learners should undertake activities like monitoring, self-testing and checking that help them diagnose and judge whether they are still pursuing the goal they had set. Because teachers and trainers can not look into the heads of the learners and are always at a certain distance of them, both physically and psychologically, learners better take care of their own monitoring and testing at least partially. Moreover, it means that learners should be or become aware of their way of learning through reflection. By thinking about their (way of) learning they acquire metacognitive knowledge that will help them master future learning.
Some other characteristics of good learning, involving the shift towards experiential learning and described in the recent literature, are that learning should become more discovery-oriented, contextual, problem oriented, case-based, social, and intrinsically motivated. These shifts can be interpreted as shifts toward experiential learning.
Discovering knowledge and insights oneself, or learning in an inductive, inquiry instead of deductive receptive way, brings, according to the literature all kinds of positive effects, like intrinsic motivation, durability, transfer etc. In our view learners are discovering all the time. Learning is essentially inquiry learning. This does not mean, however, that all instruction should be organized in the way Ausubel (1963) and others described discovery learning as an instructional strategy.

Another characteristic of good learning is contextualization. Many instances of school learning are too much decontextualized and many improvements can and should be made as to the contextualization of school learning. Real-life and connections with applications are important aspects of good learning. The key problem is that there should be a balance

between contextualization and decontextualization. Not the question whether there is contextualization and decontextualization, but their interrelations and their timing are the important issues in learning. Good learning should be problem oriented and case -based. Problem orientation and organizing learning around cases clearly is good for contextualization and motivation. Problem orientation strengthens the connections between semantic and action representations. Cases connect episodic and semantic representations.
The position that good learning is social or even that only social constructions of reality are possible is strongly defended. More and more, learning is seen to be a social process in which people interact with perspectives of other people. This does not imply that these other people should be present during learning. People can also discuss and interact with themselves (with a virtual other) and be social in this way. Moreover, social aspects of learning can also be built into teaching materials and computers. Learning together with real other learners can be a very powerful form of learning, in which learners help each other's construction processes. Many studies show how powerful social learning environments can be (see for instance Palincsar and Brown, 1984).
The last characteristic to be considered is intrinsic motivation. Good learning can have some connections with intrinsic motivation, but many times it will not. Convincing arguments were put forward by Brophy (1988). It is not the kind of motivation that comes out of the materials and the environment that is the most important, but the motivation to learn. This means being motivated to find out certain things, to have a desire for knowledge, to like learning and to keep on learning even if its relevance is not immediately clear or when it gets boring.

Conclusion
Developments in the learning and information society as well as in learning organisations, ask for new learning outcomes which can be reached according to recent learning theories through both a shift towards action learning and towards experiential learning. We need, in other words, a new balance between guided learning, action learning and experiential learning. CSCL can be the vehicle to implement the changes in schools needed for this new balance needed for the new outcomes.

2.2 FACILITATING PRACTICES OF KNOWLEDGE BUILDING IN EDUCATION

Kai Hakkarainen

INTRODUCTION

Scardamalia and Bereiter (1994) have proposed that expert-like processing of knowledge could be facilitated in school by organizing a classroom to function like a scientific research community and guiding students to participate in practices of progressive scientific discourse. Thus, schools should be restructured as knowledge-building communities through facilitating the same types of social processes, such as a collaborative effort to advance knowledge, that characterize progressive research teams and laboratories. Characteristically scientific communities work to produce knowledge, take the ideas created as an object of inquiry, and collectively pursue advancement of the knowledge constructed.

Scardamalia and Bereiter (1994) have, further, argued that there are *no* compelling reasons why school education should not have the dynamic character of scientific inquiry. The analogy between school learning and scientific inquiry is based on a close connection between processes of learning and discovery. Inquiry pursued for producing new knowledge and inquiry carried out by learners working for understanding new knowledge are based on the same kinds of cognitive processes. Learning, analogously with scientific discovery and theory formation, is a process of working toward more thorough and complete understanding. Although students are learning already existing knowledge, they may be engaged in the same kind of extended processes of problem solving and productive working with knowledge as scientists and scholars. In order to adequately understand and explain basic characteristics of this kind of progressive inquiry, we need to question current conceptions of knowledge and learning.

From Mentalistic to Pragmatic Conception of Knowledge

In the manuscript of his new book "Education and Mind of the Knowledge Age", Carl Bereiter proposes that current practices of learning and instruction are based on an assumption that human mind of a kind of container or archive and learning accordingly is an accumulation of knowledge in the mind. In education and training, knowledge is often understood as a content of the human mind, and instructors' efforts focus on transmitting desired pieces of knowledge into students' minds. In the background of this metaphor is the traditional view of knowledge as a 'true well-justified belief', i.e. a particular kind of mental state. This metaphor has had very strong influence on our attempts to instruct and assess achievements in the educational system. According to the traditional view, knowledge is simply transmitted to a student's head from the teacher's mind or books. Limitations of this metaphor become evident when thinking about the huge amount of information that is available. It is virtually impossible to manage the transmission task successfully, and we would need to conceptualize the whole learning process differently.

The modern constructivist conception of learning (see Steffe & Gale, 1997) on the other hand, which emphasizes the learner's active role in the learning process, is also based on the mind-as-container metaphor. The constructivist view differs from the knowledge transmission theory by assuming that knowledge is created by the mind itself. The problem for the constructivist conception of learning is that the theory has not become more specific during the last 10-15 years. It may help us to understand how knowledge is represented in the human mind, but it does not help to understand knowledge that cannot be reduced to mental states. The problem is to explain how knowledge can simultaneously be within the human mind as well as an object of social activity.

Bereiter argued that in order to understand knowledge processing typical of advanced knowledge society requires overcoming of the mind as a container metaphor. His approach relies closely on Karl Popper's (1972) distinction between physical reality (World 1), the mental world (World 2), and the world of cultural knowledge (World 3). Tables, oranges, mountains, earth, molecules, atoms and so on are examples of objects of World 1. World 2 consists of an individual's beliefs and mental states. World 3 is the world of cultural knowledge and consists of cultural artefacts, such as language, scientific theories and ideas. The problem of the mind-as-container metaphor is that it allows one to distinguish only mental states (World 2) and physical reality (World 1). The metaphor misses or ignores Popper's World 3 that contains human thoughts and ideas that a culture carries along. The world of cultural knowledge consists of cultural-historically developed knowledge, such as the thought-content of various scientific, artistic or other cultural products that continue their existence even after the humans who have created these ideas have died. World 3 objects are made by humans and have a history of their own. The objects of World 3 cannot be reduced to Worlds 1 and 2 but exist independently of individual minds and independent of their creators. Although there are conceptual problems concerning Popper's World 3 (e.g., whether it would be possible that claim that these knowledge objects would exist without any human agency), this approach may produce new innovations and practical solutions for understanding and explaining human thinking and educational activity.

The educational relevance of Popper’s world of cultural knowledge is based on a fact that CSCL environments provide a classroom or another learning community, a local plane of objective knowledge (Scardamalia, Bereiter, & Lamon 1994). A network environment’s database functions as a collective memory that allows the community to produce and share knowledge as well as build on each other’s cognitive achievements.

Towards Collaborative Effort to Advance Communal Knowledge

Bereiter proposed that the development of a knowledge society has given rise to discussion of knowledge as a thing that can systematically be produced and shared between members of a community. In modern enterprises and science knowledge is considered to consist of objects or "things" (e.g., product plans, business strategies, marketing plans etc.) that can be systematically produced, developed, purchased, and sold. Some writers are even talking about knowledge-creating companies (Nonaka & Taceuchi, 1995). Correspondingly, scientific research groups are typically working with theories and models that may be understood as shared knowledge objects rather than as representing mental states. Naturally, also learning certainly does occur in the business world and scientific research, but it is not the main focus of these domains of activity that focus on creating new ideas and developing of these ideas. The primary goal of members of an innovative expert community is not merely to learn something (i.e., change, or simply add to, their own mental states), but to solve problems, originate new thoughts, and advance communal knowledge. This kind of communal effort to advance knowledge Bereiter calls knowledge building. A conscious effort to advance knowledge and a commitment go beyond existing knowledge and understanding, that characterize scientific research communities and high-tech companies, is only the 19th century's discovery.

Bereiter argued that cultural knowledge to be jointly advanced is almost always given an external form as written text, diagram, model or simulation. His central concept is 'conceptual artefact'. It refers to knowledge objects that are the focus of knowledge-building communities and occupy Popper's World 3. Conceptual artefacts are, for instance, thoughts and ideas that could be discussed and shared, such as problems, hypotheses, theories or interpretations. Also various questions with wrong presuppositions and wrong theories are part of the World 3. In business world, conceptual artefacts may include, for instance, ideas

and design of products developed collaboratively, different kinds of process models or plans for organizational development and change. In educational contexts, students' and teachers' own questions and theories may be regarded as conceptual artefacts.
Expert communities produce new knowledge through working on, elaborating, criticizing, and transforming knowledge objects. Analogously, students and teachers may be guided to work for advancing their communal knowledge, i.e., to systematically elaborate and articulate their joint ideas and thoughts rather than just create physical artefacts as products of their projects. Bereiter emphasizes that conceptual artefacts are real things, their understanding is real understanding, and the work that focuses on them is real work. Knowledge building emphasizes advancing knowledge through intentionally transforming and developing conceptual artefacts. Conceptual artefacts are conceptual in a sense of being abstract and non-material in nature. Rather than helping to do concrete activities, such as cutting or lifting things, conceptual artefacts help to explain and predict phenomena. They are kinds of thinking tools that help to understand the world. Bereiter argued that conceptual artefacts can be differentiated not only from mental states but also knowledge embedded in social practices and concrete tools emphasized by situated cognition (Brown, Collins, & Duguid 1989; Clancey, 1997). Conceptual artefacts, such as theories or designs, have object-like properties (in the world of knowledge objects) that help to make them objects of investigation or shared discussion.

Separating Learning from Knowledge Building

On the basis of these kinds of considerations, Scardamalia and Bereiter draw a theoretical distinction between knowledge building and learning. Even if the distinction between learning and knowledge building is not clear-cut and many activities may serve both of these purposes, the activities, in general, appear clearly distinguishable. Knowledge building means working in World 3 for the advancement of conceptual artefacts, such as theories, ideas, and models (Bereiter, in preparation). Learning, by contrast, is oriented towards changes in individual knowledge structures, towards changes in World 2. Knowledge building and learning are not mutually exclusive; knowledge building always has impact on an individual's knowledge but learning does not necessarily contribute to advancement of conceptual artefacts. To illustrate the difference between knowledge building and learning, consider the following: The primary activity of researchers is not to learn new things or skills but to create new knowledge and to add the value of conceptual artefacts. In this process of knowledge building, researchers learn things and skills that are important for them as researchers. Accordingly, Bereiter and Scardamalia distinguish three levels of knowledge processing:

1) **Incidental (non-intentional) learning** in which learning happens as a by-product of cognitive activity. Learning in everyday life usually represents incidental learning. At this level metacognition does not have any special role.
2) **Intentional learning**, a characteristic of which is a metacognitively aware effort to expand one's knowledge and understanding. There is systematic work to deepen one's knowledge and skills.
3) **Knowledge building**. There is a practice of working for producing cultural knowledge typical of scientific research groups or other expert communities. Knowledge building focuses on creating, articulating, and building different kinds of conceptual artefacts.

A significant part of everyday learning happens incidentally without a conscious effort to learn or understand things. This kind of incidental learning is not very effective (beyond everyday scope) and does not produce very deep conceptual understanding. While metacognition does not have any special role in incidental learning, it has a very important role in an intentional learning focused on understanding. Metacognitive processes and skills help us to become conscious and monitor the processes of our own thinking, understanding and learning. The third level is knowledge building that differs from the two above mentioned processes that the goal of knowledge building is not only learning but also creating new knowledge and developing and transforming existing knowledge. It does not primarily serve individual learning but communal knowledge advancement. Knowledge-building communities are working for knowledge advancement rather than promoting individual learning; learning is a by-product of participants' efforts to advance their shared understanding.

In practice, intentional learning and knowledge building have similarities; they may be advanced by relying on the same kind of practices. Yet creating and further developing conceptual artefacts, in a particular context, is only a characteristic of the knowledge-building process. Through participating in a knowledge-building process a student, of course, engages in activities that are also likely to facilitate his or her individual learning. Even if all of us are learning, however, not all of us are working for producing and advancing of conceptual artefacts.

Facilitating Knowledge-Building Discourse in Education

The theory of knowledge building focuses on conceptualising productive practices of working with knowledge that characterize innovative scientific research groups and knowledge-creating companies. Although cognitive research on computer-supported collaborative learning provides some evidence that young students are able to participate in this kind of good practices of working with knowledge (see, for example, Hakkarainen 1998a; Hakkarainen 1998b; Hakkarainen 1999; Hakkarainen & Lipponen 1998; Scardamalia & Bereiter 1993; 1994), this evidence still rather fragmentary and unsystematic in nature. A further research in needed in order to determine to what extent students collaborating within computer-supported classrooms would be able to engage in progressive discourse that facilitates advancement of their explanations and inquiry in a way that is analogous with mature knowledge-building communities. In the following are provided certain essential characteristics of knowledge-building discourse that should be facilitated in education:

Facilitating discourse focused on conceptual artefacts.

A characteristic of knowledge-building discourse is that it is focused on conceptual artefacts rather than server mere social correspondence or physical artefacts that are produced during a study project. It follows that discourse within a community gets organized around different kinds of knowledge objects, whether those are students' own observations, narratives, intuitive theories or scientific explanations. Working with these knowledge objects breaks the boundaries of activities focused of facilitating one's own learning; after created these knowledge objects can be used by other members of a community to advance communal knowledge.

Engaging in progressive discourse

is an important characteristic of knowledge building. In order to be progressive, discourse interaction should focus on systematically articulating and advancing conceptual artefacts rather than treat those as final truths (Bereiter 1994). It is important that students learn not to "take" (Olson, 1994) scientific knowledge to represent infallible and ultimate truths, but rather as explanations constructed by scientists to answer certain problems connected with the natural, biological or social worlds. Characteristic of progressive discourse is mutual advances in understanding, empirical testability, expanding the basis for discussion, and openness. The overall focus of the progressive discourse is on pursuing understanding, on seeing knowledge as problematic and something that needs to be explained (Chan, Burtis, & Bereiter1997).

Facilitating explanation-oriented discourse.
An essential characteristic of knowledge building is discourse that focuses on advancing and articulating explanations. Explanations and theories are complex conceptual artefacts; tools that help us to explain how things work in the world. It is typical for knowledge-building communities to work for advancement of explanations through solving explanation-seeking questions.

Facilitating a cognitive commitment to deepening inquiry.
A critical condition for progress is that an actor focuses on improving his or her theories by generating more specific questions and searching for new information (Hakkarainen, 1998; Hakkarainen & Sintonen, submitted). The main point is to ensure that knowledge object a community shares and is working on are progressing in the course of inquiry. Towards this end, it is very important that students acquire confidence that the world makes sense, although there are many things that are very difficult to understand, and continuously try to go beyond his or her current level of understanding and produce more articulated conceptual artefacts. A commitment to expand the body of community's knowledge.

Providing Technology-Support for Practices of Knowledge-Building in Education
Provision of tools for collaborative building of knowledge is characteristic of CSCL environments. Sophisticated environments designed to support expert-like processing of knowledge by guiding students to work collaboratively to improve shared knowledge objects may be called as knowledge-building environments (Bereiter & Scardamalia, 1997; Scardamalia & Bereiter, 1996; Stahl, 1999). Through these kinds of environments, students may be guided to engage in productive working with knowledge objects in the same way as the scientific community is engaged with theory improvement. A very effective way of learning to understand and explain a knowledge object is to generate another object (e.g., hypothesis, theory) based on it (Scardamalia, Bereiter & Lamon, 1994). Practices of working transformatively with knowledge are facilitated, for instance, by CSILE through providing students with a shared space for working together with knowledge produced by the students (Scardamalia et al., 1994). The students are guided to construct their own research questions and intuitive theories as well as report scientific information found by them in CSILE's database. CSILE's public database creates a plane in which students can jointly work toward advancing their communal knowledge.

Facilitating Externalization of Thought through Writing and Visualization.
Technology-supported learning environments provide advanced tools for writing and visualization. An important aspect of CSCL is to systematically guide students to use writing and visualization as vehicles of thinking instead of relying merely on internal processing of knowledge. The cognitive value of writing and visualization is based on the fact that human beings have only limited cognitive resources; by externalizing one's psychological processes and representations inquirers are able to reduce the cognitive processing load and solve problems that were otherwise completely unattainable (Olson; 1994; Pea, 1993; Vygotsky, 1978). Writing forces a student to derive certain conclusions from his or her beliefs and theories and thereby articulate them more thoroughly. By providing dynamic tools of visualization, such as concept maps, the students can be encouraged to use visual representation for representing conceptual knowledge; thereby facilitating explication of the inner relations of the phenomenon being explained (compare Pea, 1993). Through

visualization, advantages of the powerful human visual system can be used to facilitate conceptual understanding (Edelson, Pea, & Gomez, 1996). In order to facilitate extensive thinking, practices of writing at school should be focused on constructing, articulating, and communicating knowledge (Geisler 1994). For such focus, knowledge-building environments designed to facilitate the use of writing as a tool of inquiry, provide strong support.

Providing External Structures for Facilitating Expert-like Processing of Knowledge. Technology-based environments for CSCL often provide external structures that help a student to participate in expert-like processing of knowledge without increasing processing load. This kind of procedural facilitation provided during the process of inquiry enables students to achieve their zone of proximal development and solve more complicated problems than they would otherwise be able to do (Scardamalia & Bereiter 1994). By relying on cognitive research on expertise in different domains of knowledge, one can help users to structure their problem-solving efforts in the same way as experts do. There is evidence, for example, that CSILE’s thinking types Problem, My Theory, New Learning, Plan, Higher Level Question, and Comment structure cognitive activity in a way that corresponds to fundamental aspects of progressive inquiry.

Facilitating Progressive Discourse and Collaborative Learning.
A fundamental aspect of CSCL environments is to provide users tools for posting knowledge productions into a shared working space and providing tools for progressive discourse interaction between the users. Through these kinds of collaborative learning tools, the users are able to rely on the socially distributed resources of the learning community in conduction of their study projects (Salomon, 1993; Oatley, 1990). A collaborative process of inquiry in the new networked learning environments seems to have the potential to encourage students to work at the edge of their competence rather than rely on routine problem solving. Pea (1994) argued that computer-supported collaborative learning can foster transformative communication that facilitates new ways of thinking and inquiring in education. It seems that for the purposes of transformative communication, written communication, combined with face-to-face communication, is more effective than face-to-face alone because it requires more extensive thinking processes (Lamon, 1992). CSILE facilitates transformative communication by providing sophisticated tools for written communication between students.

Facilitating Metacognitive Development and Learning to Learn.
Computer-supported collaborative learning appears to engage students to participate in in-depth inquiry over substantial periods of time and to provide socially distributed cognitive resources for comprehension monitoring and other metacognitive activities. A central principle of CSCL is to provide structures and activities that foster monitoring of one's own and the other students' comprehension and reflect advancement of inquiry (Brown & Campione, 1996). Collaborative learning in which thought processes are externalized in the form of public discourse provides each student access to other participants' processes of thought, making metacognitive processes (e.g., comprehension monitoring), which cannot normally be observed, "overt, explicit, and concrete" (Brown & Palincsar, 1989, p. 417; Brown & Campione, 1996). In order to foster self-regulated learning, the networked learning environments do not constrain the users' activities, but encourage the users to regulate and monitor their own as well as their fellow students' advancement. It is important that the learning environment makes all stages of inquiry visible, not just the end result. This, in turn, would make progress of conceptual understanding become salient to the student as well as his or her fellow inquirers.

Creating connections between cultures of schooling and expert cultures.
An important condition for development of expertise is a close connection with an expert community. The new networked learning environments provide significant support for breaking the boundaries of traditional school and creating connections between schools and expert communities. Complex and meaningful problems cannot, in many cases, be solved by relying on the resources of the learning community including the teacher. Frequently, however, interaction and collaboration with experts may also help the students to solve their problems and adopt expert-like practices of working with knowledge. By the means of computer-supported collaborative learning environments practices of schooling may be transformed toward practices of expert communities.

Providing Access to Extended Sources of Information.
Technology-supported learning environments provide the students access to extended sources of information through Internet or CDROM-based encyclopedias. These resources facilitate the students learning as far as they are used for supporting the students' own learning, not to replace their cognitive efforts. When the students are using these environments for searching answers to their own research questions, meaningful and productive use of available information is significantly facilitated.

Providing Tools for Publishing Results of Inquiry.
Further, technology supported learning environments provide means for publishing the results of the students' own inquiry. If the students' process of knowledge building focuses on creating an artifact (i.e., a research report or a hypermedia product) to be published, this tends to change the psychological nature of the process of inquiry. The students have to consider their productions from the viewpoint of the audience, and this may push them to pursue the problems being investigated at the deeper level. However, it is very important to notice that the artefacts or external products created through CSCL are not the main focus of progressive inquiry. The problem is that, in many cases, activities focused on producing an end result of inquiry learning takes over and makes learning of anything else difficult (Bereiter, in preparation). The whole rationale of the process is to advance the learning community's understanding about the ideas and concepts being investigated.

3. SCIENTIFIC DESCRIPTION OF THE PROJECT RESULTS AND METHODOLOGY

3.1 DESCRIPTION OF SOFTWARE

Stijn Dhert, Raf Canters, Joost Lowyck

Introduction

This chapter reviews the different software used by the various CL-Net partners. The central objective of the CL-Net project is to investigate the cognitive and didactical aspects of computer-supported collaborative learning networks. Therefore the partners created environments in which technology and software contributed to 'strengthen' the teaching-learning environments, based on the conception of learning and teaching defined as a constructive, cumulative, self-regulated, goal-oriented, situated, collaborative, and individually different process of knowledge building and meaning construction. The different software that have been used are: WebKnowledge Forum (Greece, Belgium (Flanders) and the Netherlands), its predecessor CSILE (Finland), Our World and Discover Your Town/Our Castle (Italy) and WorkMates4 (all partners). See Table 1 for an overview of the different software that has been used by pupils.

Country	University	Level of Education	Content Area	Software for student users population
Italy	Institute of Psychology of the National Research Council, Rome University of Bari	Upper Elementary (4th grade) Lower Secondary (1st grade)	Environmental Education	Our World
	University of Rome - La Sapienza, University of Bari	Upper Elementary (4th grade) Lower Secondary (1st grade)	(Socio-)Historical Education	Discover Your Town/ Our Castle
The Netherlands	Wageningen Agricultural University	Vocational Education	Agricultural Education	WebKnowledge Forum
	University of Nijmegen	Secondary (3th & 4th grade) and undergraduate	History, Biology and Physics	WebKnowledge Forum
	University of Amsterdam	Elementary	No Specific Content Area	Intranet (CIAO) Web Knowledge Forum
Greece	University of Athens	Upper Elementary (6th grade)	Science	WebKnowledge Forum
Finland	University of Turku	Upper Elementary (4th grade) Secondary (2^{nd} grade)	Biology Science and Literacy	CSILE (for Mac) CSILE (for Mac)
Belgium	University of Leuven	Upper Elementary (5th & 6th grade)	Mathematics	WebKnowledge Forum

Table 1:
Overview of the different test sites as well as the different software learning environments

Hereafter we will discuss the different software, based upon information of their actual status at the time of writing. In order to do so, we first present the educational philosophy, underlying the different software. In the second section we elaborate each application, taking into account a number of didactical and pedagogical relevant aspects. From an analytical point of view, this mainly involves four important dimensions: (1) the *didactical dimension*, which has aspects such as the nature of learning materials, the nature of learner control versus teacher or program control and the nature of support; (2) the *structural dimension* of software interface and concept; (3) the *functional dimension* of content relatedness; finally, we are interested in (4) the *technological dimension* of the different software as well. The division in dimensions must not raise the idea that these are separated elements. On the contrary, all dimensions and aspects are closely intertwined (e.g., the didactical aspect of learner control of an application, should be reflected in the structural aspect of software interface.) Therefore we will not specifically address these dimensions on a one-by-one base as we elaborate on the software programs. In the third section though, we will take an explicit closer look at these dimensions, by synthesising the specific focus that each of these software tools has. Hereby pinpointing what makes these applications different even though they have a common ground.

Literature clearly shows that the high expectations accompanying the introduction of computers in schools in the early 1980s have not been fulfilled. Neither by computer-assisted instruction nor by intelligent tutoring systems (De Corte, Verschaffel & Lowyck, 1996). This relative failure of educational computing effects is largely due to an inadequate fulfilment of conditions for computer applications in education, namely as an add-on to an existing and unchanged classroom setting. Underlying these applications is the traditional conception of learning as a rather passive process of information absorption. In contrast, the software and its use in the present project must be seen in the new and productive conception of educational computing, where computers are embedded in powerful learning environments as tools that can elicit and mediate in a community of learners, active and increasing self-regulated processes of collaborative knowledge acquisition, meaning construction, and problem solving (De Corte, 1996). 'Embedded' means here that the computer and its software are not just an add-on, but that they are judiciously integrated in the environment, capitalising on the ICT's specific strengths and potential to present, represent, and transform information (e.g., simulations of phenomena and processes), and to induce effective forms of interaction and co-operation (e.g., through exchanging data, information and problems via a network) (see Kozma, 1991). In this perspective, the software fosters articulation in two ways: by enabling students to transform their ideas into testable artefacts; but also by offering tools and situations allowing learners to articulate their ideas and solutions to the teacher and to their peers (Verschaffel, De Corte, Lowyck, Dhert & Vandeput, 1998). Moreover, the software can stimulate reflection in and among students through comparisons of their performance with that of an expert and through replays and reifications highlighting critical steps in a problem solving process or learning task fulfilment.

The different software used by the various CL-Net partners share a common ground. They all share a constructivist epistemology (as opposed to an objectivist epistemology, Thorndike, 1913) as well as a constructivist collaborative approach to teaching and learning (as opposed to instructivist approaches, Reeves & Harmon, 1994). The software programs used in the CL-Net project all support a concept of knowledge as a human (collaborative) construction and a socio-cultural interaction between 'experts' and 'novices' (like in scientific research communities), putting individual thinking in a wider, social context. The applications can be seen as tools for creating a virtual multimedia community of learners, in which learning is to be seen as a constructive, authentic, situated (real life) and collaborative process, by offering a powerful learning environment (Dillemans, e.a, 1998).

Description of the Software

CSILE and KF

The Computer Supported Intentional Learning Environment (CSILE), developed originally in the late eighties (Scardamalia & Bereiter, 1991, 1992, 1994, 1998; Scardamalia et al., 1989), is a networked learning environment for fostering higher-level processes of inquiry in education. The first research version of CSILE was installed in 1986 into two grade 5/6 Toronto classrooms using a local area network. In 1997 the second generation CSILE was launched, namely a commercial version of CSILE called ‘Knowledge Forum’ (KF). CSILE and KF are environments for building, articulating, exploring and structuring knowledge. The design is based on an ingenious application of recent research on expertise, literacy, collaborative cognition and complex problem solving. KF and CSILE are network systems that provide ‘across-the-curriculum support’ for collaborative learning and inquiry. At the centre of the software is a communal database that can be filled with notes by students and their teachers. Typical notes include a question or a problem, a graphic illustration, a research plan, or a summary of information found from resource materials. Pupils or students enter their

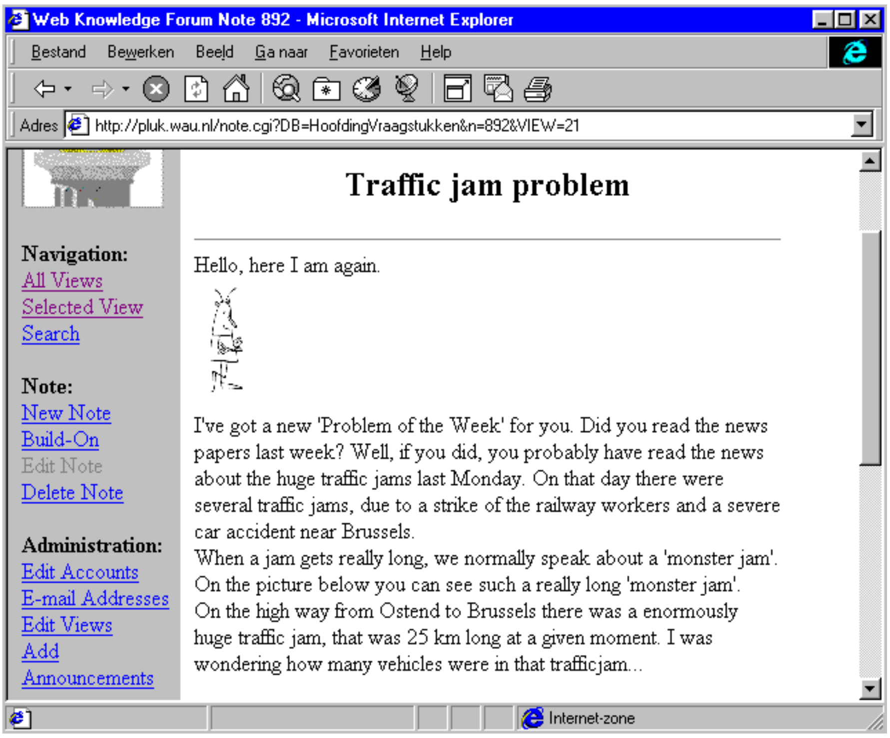

Figure 1:
Knowledge Forum Web. An example from the Belgian Classes: ‘the Traffic Jam Problem’.

notes into a common hypermedia, student-generated database that is accessible to all participants (pupils/students and teachers). Participants can retrieve and examine each other’s notes, quote, build on and react upon each other’s notes, and authors are notified when comments have been made on their note. As the designers indicate, CSILE and KF are much more than just tools for ‘posting’ information: ‘*It is the meeting place - the Forum, if you will - where students build a body of knowledge*’ (Scardamalia & Bereiter, 1998).

CSILE and KF are examples of carefully developed CSCL tools, which bring the principles of knowledge building and sharing into authentic practices of learning. The environment supports students' learning by providing tools for inquiry-based activities, discussion and knowledge production. Student present their own research questions, intuitive working theories and new knowledge in the form of textual, graphical and discussion notes. The basic assumption is that all notes are open to the other members of knowledge building community although students may also produce private notes. This type of knowledge sharing gives opportunities to all pupils to participate equally to the activity. CSILE contains tools for producing, storing, seeking, classifying and linking knowledge by text and graphic processing and discussion tools. CSILE supports students cognitively by helping them to articulate, explore and structure knowledge. Multiple tools for generating discussion on the topics and possibilities to comment each other's notes are essential for students, teachers and experts working collaboratively with knowledge (Scardamalia & Bereiter, 1994.)

There are two different versions of KF: a Web version (WebKF) and a Client version (only for Macintosh). In the present study, the CL-Net partners from Belgium (Flanders), Greece and the Netherlands used the Web version. Although the Web software does not offer the full range of features offered by the Macintosh Client version (in the latest version various additional scaffolds have been implemented to enhance the potential of the communal database for collaborative knowledge building), it does provide enough basic functionality to permit Web users to read all database notes, to create new notes, and to collaborate with others using WebKF's commenting, discussion and structuring facilities. Figure 1 (see below) illustrates the use of WebKF. For more information about the similarities and differences between the two versions of KF we refer to Scardamalia and Bereiter (1998; see also Verschaffel et al., 1998; De Jong and Biemans, 1998; De Jong, F.P.C.M. & Veldhuis-Diermanse, A. E., in press). At the moment of publication of this report the CL-net project has resulted in for the European Schools usable release of PC-compatible Knowledge Forum 3.0.7 with Windows NT-server and PC-client software which will give at least the same and even more advanced knowledge building facilities as in the MAC-CSILE software (Knowledge Forum: http://www.learn.motion.com/).

Generally speaking, CSILE and KF are based on the philosophy that knowledge is a human construction that takes place as a socio-cultural activity, and that it is through apprenticeship with a mature scientist that novices can acquire scientists' skills. As such, CSILE and KF are intended to support the collaborative construction of knowledge in and beyond the classroom. Using them involves changing the structure and culture of classrooms and patterning them after scientific research communities.

CSILE has been used in design experiments at primary, upper elementary, secondary and graduate school levels. There is evidence that CSILE facilitates higher-order cognitive processes and collaborative knowledge building (see Lamon, Secules, Petrosino, Hackett, Bransford, & Goldman, 1996). Evaluation studies comparing CSILE and non-CSILE classrooms at the elementary level have shown significant advantages for CSILE classrooms on standardised test scores for curricular domains like language and mathematics, but also on process-oriented measures like quality of question-raising and depth of explanation (Lehtinen et al., 1999; Scardamalia & Bereiter, 1998). Hakkarainen (1998) analysed the nature of peer interaction in a CSILE environment and the effects of the quality of this interaction on the inquiry process. The analysis indicated that the CSILE students stimulated each other for making explanatory relations explicit by pointing out that another student's note or theory was not understandable and by requesting it to be made more accessible or articulated. Hakkarainen and Lipponen (1998) compared pupils' inquiry and learning processes in different classrooms using CSILE in Canada and Finland. The results revealed remarkable differences in the ‘learning cultures’ in the distinct classes (i.e., classes with a traditional versus a collaborative culture) and showed how these differences influenced the way CSILE was applied in the classroom practices. While the collaborative class engaged increasingly in an explanation-oriented process of inquiry, the traditional class continuously dealt with factual and descriptive information. Examination of the questions raised and the knowledge produced in KF in the different classes revealed that - compared to the students from the traditional classes - the collaborative students’ inquiry was more and more explicitly focused on generating their own explanation-seeking research questions and the construction of their own intuitive explanations, as well as searching for explanatory scientific information. However, the study also showed that a collaborative culture presupposes a very strong engagement of and guidance by the teacher. More precisely, the teacher of the collaborative group gave the students a lot of (meta)cognitive support by providing an expert model of higher-level processes of inquiry. Research by Hewitt (1996) and Scardamalia and Bereiter (1996) in which CSCL-classrooms were compared to traditional classrooms showed that working with this kind of environment (WebCSILE) had positive effects on intentional and collaborative learning.

Our World

Our World has been designed as a website (see Figure 2) that affords four facilities: (1) a library split into five information databases (‘*esplorare il mondo dentro e fuori la scuola*’ = ‘*exploring the world in and out of the school*’); (2) a forum space (‘*discutere con gli altri*’ = ‘*discussing with others*’); (3) a data-entry space (‘*produrre informazioni*’ = ‘*inserting information*’); and (4) an address book (‘*cercare indirizzi per comunicare*’ = ‘*finding addresses to communicate*’[1]). The information in the database can be browsed, stored, produced, classified, downloaded, and linked to knowledge; this part of the software shares the same educational principles of CSILE and KF (Scardamalia & Bereiter 1989; 1993; Scardamalia, Bereiter & Lamon, 1994).

The design of Our World has been inspired by the aim of relating individual thinking to a wider context in which the exchange of information and ideas becomes one of the ‘ground rules’, so to speak. Even though knowledge construction in school is not identical with that of the scientific community, any social group, which is engaged in an elaborating culture, needs confrontation with and openness to others.

The organisation of the database has taken into account categories accepted in the ecological field and also young student’s knowledge. Information can be browsed, stored, produced, classified, downloaded, and linked to pre-existing files.

The forum environment can be the ‘place’ where the student’s community engages in metacognitive reasoning and shares the information at a distance. The use of Forum in OUR WORLD demands to fulfil some requirements:

- to label the opening message of a forum according to selected goals (different colours mark the differences)
- to give a title to one's own text, both when it is a message opening a new forum and when it is a reaction to an existing one
- to use no more than 1000 characters for a new opening message and 500 for a reacting one

[1] This environment has not been used in the experiment.

- to select among thinking types to mark the message (agreement, disagreement, comment, new idea, question)

The full communication flow can be visualized in order to reconstruct the knowledge building process but is possible to choose the message children want to react to. In this way a non-linear sequence of messages can be created.

Figure 2:
The software 'Our World'. The website interface offering four facilities.

The use of the program enacts the following activities within the experimental classes:

- retrieving documents from the database,
- reading and commenting retrieved documents,
- writing documents to be sent to the editorial board of the database,
- filing documents in the database,
- participating in forum exchanges: opening a forum, reading/writing contributions to the forum.

In the traditional, wide spread school practice each class works as a closed universe; teaching may be non-transmissive, the organisation of inquiry learning may include class discussion and team-work, but very seldom cooperation and the sense of being a community of learners goes beyond the borderline of the class walls. Even the class next door is merely another group of children to be met during recess or during special school events and not a group tackling similar problems or making experiences that might be integrated under common themes.

Pacing of class activities in different classes is a hard task and many reasonable and unreasonable but often out of control causes disrupt it. Curricular planning for jointly carrying out projects in different classes, even if teachers are in the same school, is very difficult. It may laboriously take place as long as someone (the experimenter in most cases) is in charge of coordination or it may occur for a short work sequence within a limited time. Being aware of these obstacles, the program Our World was designed in order to enable classes to communicate what they are doing (possibly, but not necessarily in view of performing common tasks) and to build a sense of belonging to a larger group of learners who cumulate the results of their inquiries. Transformation of any production from private to public imposes rules: these constraints can be seen as limitations but they can act as opportunities for measuring oneself with culturally accepted norms. The acceptance of the pre-organised structure of the database (where to store documents), the filter and advise of an editorial board can be seen as constraints, but are equally inputs or features that teachers can exploit to make children more aware of the relationships between what they are inquiring and the general frame where knowledge can be situated in and used by others.

Our Castle /Discover Your Town

Another Italian software used in the CL-Net project is composed by an interactive multimedia called 'Discover Your Town' and a website called 'Our Castle'.

Discover Your Town

The first group of activities makes use of the interactive multimedia Discover Your Town, which is a tool to render the history learning at the primary level more active. This hypermedia is presented as a virtual game where a town can be reconstructed on the base of information and tools contained inside the multimedia. This activity is guided by a simulated expert in history that asks the users to accomplish a mission: to find in the virtual town (Civitella) all the signs of the past and in particular about the Middle Ages and, then, to take a journey through the centuries to the Middle Ages. The history scholar (the director of the town's laboratory of history), then, asks the students to solve 5 different missions in order to collect information about life in those ages.

The software has been designed as an educational environment in the domain of history. It involves three main aims of a history curriculum. The first aim is about the discovery of the historical depth of our reality: to learn to 'see' the past. Many historical vestiges are visible in our landscapes in Europe. Learning to read these traces of the past is not only an educational opportunity and a way to motivate students, it also enables them to understand and give meaning to the environment in which they are living, that has a lot of historical places. In Discover Your Town students are requested to explore the virtual town, to recognise some features as clues to the past and to make a picture of them with a virtual camera. The clues are of different levels of difficulty: there are typical medieval buildings, like a cathedral, castle, monastery, but also manufactures and documents that students can find, for example, in the town hall. There are also more difficult clues, as the name of some streets or an oval-shaped square where tournaments in the Middle Ages took place. Giving these clues to the taxi driver, students can make a journey through the time. Each clue allows the students to enter a particular part of the medieval town. There are 9 different parts, each one related to a different topic (see below). To explore the entire town and to collect information about all the topics, students must find all the clues to the past by exploring Civitella at the present.

The second aim is to offer a reconstruction of 'scenes of the society'. Discover Your Town is also a tool to allow children to reconstruct an image of the human society in the Middle Ages. To accomplish this aim, 9 different topics have been identified that enables students to reconstruct the life of the town in its different dimensions (politics, religion, economy, culture, every day life, etc.). Students can visit Civitella in the Middle Ages (as shown in

Figure 3), with the help of a taxi driver who transforms himself into a mad-scientist and takes the students to the Middle Ages: in each scene, he gives them information about where they are and what is happening. In general, this information is about differences between the past and the present. The aim is to introduce students to the life in the past. Each scene also presents general or particular information about one of the historical dimension we mentioned above.

The different dimensions are interrelated; the overall picture that follows is a ‘model’. As all models, the town of Discover Your Town is virtual: it is artificially constructed, selecting the more typical features of European towns that are associated with the Middle Ages. And, as all models, it requests to be tested and specified in relation to the different realities. To do this, Discover Your Town provides a collection of pictures of squares, churches, roads, buildings and other things that date back to the Middle Ages and that still can be actually seen in real towns.

Figure 3:
The software ‘Discover Your Town’. A reconstruction of the main square of Civitella in the Middle Ages. You can enter different places (cathedral, town hall…), consult the taxi driver or use the video-telephone to consult the archives.

Students are supported and stimulated in their exploration of the medieval town by 5 different tasks that the director of the historical lab gives to them. These tasks are related to the main mission: to give help to a movie director who wants to shoot a film about the Middle Ages. The tasks are given to the students during different moments of their exploration; they can solve them suddenly or skip off and continue their exploration, coming back later to the tasks. (1) The first task is to select from a set of pictures, one or more pictures that can be used as scenery for the movie. In this set, the pictures present architectural characteristics, some of which are from the medieval period and others of which are not. (2) The second task requires the students to verify whether a list of objects selected for the movie is historically reliable. To solve this task, students can explore the house that is represented in Civitella or consult iconographic documents about medieval houses that are present in the Hypermedia. (3) The third task is to write down a dialogue between two merchants. Students are invited to consult documents about merchants in the Archives. (4) The fourth task is to suggest to the movie-director a story related to the town's history. Students have to compare the maps of Civitella in the Roman Era and in the Middle Ages, in order to find aspects of the landscape that have or have not changed. (5) The fifth task requires students to complete information and dialogues in one part of the town: the monastery. Students must work together to collect information not only in the archives of the historical lab, but also in books or while visiting an ancient monastery.

The third aim of Discover Your Town is to help students practise historical methods and procedures. Therefore the program provides archives of documents and suggests activities for analysing these documents. The 'archives' are one of the central places and functions of the program. They contain materials of different kind and can be consulted using key words. (see Figure 4) The material is organised into four categories: visual sources (pictures, paintings, sculptures and so on), written sources (official documents, letters, testaments, sermons, etc.), cards about particular topics and pages written by historians.

Figure 4: The software Discover your town. One of the visual sources that are collected in the archives: the spice shop

OUR CASTLE

The second group of activities involves visiting and constructing the website. 'Our Castle' is not a real software but a website where kids exchange information and materials with the aim of building an hypertext about a medieval castle. Figure 4 presents an illustration of the interface design of Our Castle.

Figure 5:
The website 'Our Castle'. One of the pages of the 'pictures' gallery (in Italian).

On this website information and research materials are exchanged between classes that participate at the common project of developing a hypertext about a castle. It provides one forum to change information between students and another one for teachers. In addition, there are pages organised as a database where students' contributes can be stored, browsed and downloaded. Contributions are stored in different categories: projects, backgrounds, pictures, sounds and documents. In the 'arena' section (the students' forum), children discuss their and other classes' contributions and they decide together how to project and build the hypertext about the castle. Our Castle supports collaboration at two different levels: (1) a forum were students can exchange messages and (2) the archives, organised as a database where students' contributions can be stored in different categories, browsed and downloaded.

WorkMates 4

The development of WorkMates groupware started from the need for WWW-based communication between university students. The first version was done in 1997 in the University of Turku, Finland. Newer and better features, based upon first-hand experiences and users feedback, were finally concluded in the WorkMates 4 (WM4) in 1998. The development is still continuing, but from a different approach. The main focus in using WorkMates is supporting collaborative aspects of group work through the web. Document sharing, commenting and referencing can be used to achieve collaborative learning in a time- and place-independent way.

The WorkMates application is used with a web browser. People who want to use it, contact the administrator who will open a new instance for them. Every user gets a user name and a password to connect to the server. The hosting server is offered for free by the developers, but the code for the program can be downloaded to a local server. The design of project categories or course milestones is done by the project leader. (S)he creates the main topics for discussions or subprojects. This way the documents have a tree-like hierarchy. This organising phase is critical and it is often connected to a schedule. A clear vision of the work placed in the environment is needed to make the work more effective. When the overall structure is defined, users can make new documents to appropriate folders in the document tree. This is done by double clicking the folder or document that will include the new document. When the document title and the text body is done, it is possible to give different rights to this document. Some groups or people can have ‘write access’, some others can have only ‘read access’ to the material. This is something to take into consideration to make people really collaborate; ‘read access’ makes it also possible to make comments and ‘write access’ to make references to other documents or other web pages.

The main part of the working activities is situated in document reading, document editing and commenting or referencing (see Figure 5 for an example of document reading facilities in WM4). In addition, e-mail and chat facilities are supported in an easy-to-use way. File uploading is also possible, because a great deal of work is situated in programs like Microsoft Word. In order to make a comment in a document, it suffices to double click on the place where one wants to add a comment. Next, ‘commenting’ or ‘questioning’ can be selected to bring different semantics with the same technique. This makes it easier to distinguish the questions from comments, when reading the document. Every comment is indicated with a small icon. By clicking this icon, the comment and comment related information can be viewed in its context. It is also possible to make a link between two WorkMates documents. These links are called ‘references’ and they have a selectable attribute ('for' or 'against'). Likewise a comment, a reference is marked with a small icon created by double clicking. Now the clicking on the icon leads the user to the referencing document. To make a link to outer sources, like WebPages for instance, a similar procedure is introduced. After a double click on a selected document, an URL address can be added next to the clicked word. The messages and help systems are very modular. This makes it possible to separate the language from the program application. At this time, the WorkMates software supports Finnish, English and Dutch. The administrator can switch the language from one to another on the fly.

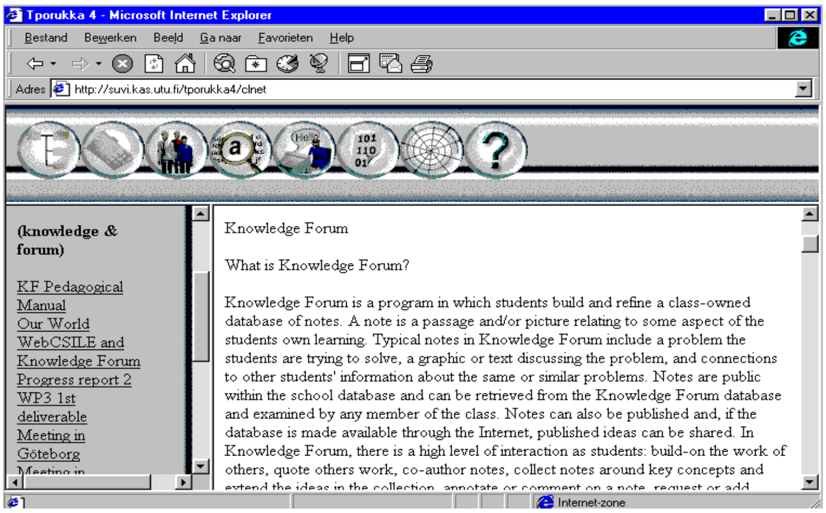

Figure 6:
The software ‘WorkMates 4’. An example of document reading.

More than 30 users from different countries of the CL-Net community used WorkMates 4 from the beginning. The development of WorkMates was greatly encouraged due to the feedback from this community. The work situated in this WM4 version was organised into several work packages, that were used as containers for the contributions. For example, in work package 1 documents like ‘Teacher Manuals’ were placed in the ‘WP1: Preparation’-folder. In this asynchronous environment it was quite easy to comment materials made by other participating universities. However, one of the most used featured seemed to be file uploading. Centralising material was also an important aspect, because of the CL-Net's distributed nature.

The WM4 use offered valuable feedback on building a CSCL environment. This experience will help the development of future concepts, based on WorkMates. One of the main ideas generated from the WM4 usage was a paradigm shift: a program that aims at containing as much features as possible in today's software technology, may not be the ultimate solution. The technical possibilities seemed even to grow during the program development. This challenge of fast, cyclical technological development leads to the creation of more modularised environments. With this enhanced modularity, it seems easier to replace a part of a program by a newer version. The independence between modules makes it also possible to access and view the material in a more flexible way. The file sharing, WWW-based approach and future technical evolutions can co-exist if the environment focuses more on the material. The meta-knowledge included in extensible Mark-up Language (XML) files seems to be a technology that many organisations are implementing. The next generation WorkMates will have a similar open and descriptive approach.

SYNTHESIS

In the above section of this chapter, we have separately described different software applications used in the CL-Net project. In the introduction we already indicated that these tools have a common ground, although each of these applications has its own specific focus, stressing particular issues or dimensions. Table 2 presents a schematic description of the different kinds of dimensions and related elements with possible scopes that could be taken into account for a dimensional analysis.

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DIMENSION	ELEMENTS & POSSIBLE SCOPES
Pedagogical	- *philosophy (instructivistic versus constructivistic)* - *psychology (behavioristic versus cognitivistic)*
Didactical	- *nature of learning materials* *(open versus closed; cognitive interactivity level; differential possibilities)* - *learner versus teacher/software control* *(internally versus externally control)* - *nature of support (e.g., instructor; coach; process manager; …)*
Structural	- *software concept (e.g., discovery learning; problem-based learning, …)* - *software interface (e.g., text based; game-like, …)*
Functional	- *content-related versus content-free*
Technological	- *technical specifications*

Table 2:
Dimensions of interest for analysis

When comparing the different software programs, we can extract the following key differences:

1. Didactical dimension
2. Structural dimension
3. Functional dimension
4. Technological dimension

1. Didactical dimension

CSILE and KF are both content-free tools and provide across-the-curriculum support for collaborative learning and inquiry. In contrary, Our World and Discover Your Town/Our Castle are content-bound software, that are exclusively created for environmental education (Our World) and history education (Discover Your Town/Our Castle) in the primary school level (see also under 'functional dimension'). Nevertheless, there are some important didactical differences between the last two software applications. Discover Your Town is a more or less pre-structured information environment that children have to explore in order to find 'clues' about the past. Relying on these clues and on the different hints (e.g., the taxi driver) to find these clues, pupils can explore the historical virtual reality, created in the interactive multimedia. Central aim of the learning environment is to actively re-build the virtual medieval town Civitella. Our Castle holds the second group of activities: pupils can exchange information and materials on the website with the aim of building a hypertext about a medieval castle. Here, the individual nature of the first group of exploratory activities is 'uncorked' and inter- and intra-class exchanges come about in order to jointly develop the hypertext (built upon the knowledge about the Middle Ages, that the pupils have gathered in Discover Your Town). It is at this stage that the interactive and collaborative surplus value of ICT makes it entrance in the history-learning environment. Although Our World is a content-bound environment, it shares more or less the same educational principles with CSILE and KF. Just like these software applications, the major aim of Our World is to incite pupils to interact and to collaborate with each other via the software in order to construct and build knowledge about the world they are living in. Unlike CSILE and KF, but just like Discover Your Town, one of the facilities of the software is a built-in library (maintained by the '*Comitato di Redazione Il Nostro Mondo'*, the '*Editorial Staff of Our World'*), in which pupils can find more information about different environment-related topics. Most of the contributions in this library are from the editorial staff, but pupils are also allowed to post their contributions into the library, where they will be published, after the editorial staff has checked and approved the contributions.

Concerning teacher or program control versus learner control, we can say that CSILE and KF are designed to give pupils the opportunity to structure the software databases themselves, by contributing new notes and build-on notes to the databases. This makes it possible to use the software for quite diverse groups, whereby a teacher can decide – depending on the meta-cognitive skills and other characteristics of the student-group – to act as an instructor or as a facilitator or coach. External guidance can always be implemented, for instance by giving pupils instructions about when to contribute what kind of notes. Same goes for Our World and Our Castle, however more support is given by the structure of the software itself. Discover Your Town has a somewhat different aim, which is also reflected in the interface of the software. The hypermedia is presented as a virtual game, guiding the learner through a certain number of tasks in order to reconstruct the medieval town. As can be seen in the software description above, the application structures the learning environment in a non-negligible way.

2. Structural dimension

Both CSILE and KF are rather straightforward learning environment tools. The graphical user interface of both applications consists of a student-generated database, subdivided in a number of views. Once one has selected a particular database and logged-in via username and matching password, he or she enters a typical HTML (Hyper Text Mark-up Language) surrounding with text-based menu options (e.g. 'view note', 'edit note', 'search'). WM4 is very much like this, although it uses both icon as text-based menus, as well as an overall tree-like hierarchy. The Our World and especially Discover Your Town/Our Castle software is much more graphically oriented. The Our World software interface uses a pictorial language to facilitate queries and to simplify the comprehension of the structure of the database. The concept and looks-and-feels of Discover Your Town is actually indeed game-like, which makes it very suitable for either younger children (because of the visually attractive and thus motivational interface), or for children with little or no experience with collaborative learning approaches, who can get those first experiences in a very child-friendly environment.

3. Functional dimension

CSILE/KF and WM4 are content-free, or content-empty software applications, where as the Italian programmes have a fixed content setting. CSILE/KF have been used in the CL-Net project for curricular domains like mathematics (e.g., solving mathematical application problems in Belgium (Flanders)), science (e.g., biology in the Netherlands and chemistry in Finland) as well as social studies (e.g., history in the Netherlands). CSILE's design is based on the idea that a computer system should not replace a student's thinking, but guide students to think them selves, and to learn by writing. The system is designed to provide procedural facilitation, i.e., tools which scaffold the students to perform cognitive operations that they would not be able to do on their own. WM4 has been used as a communication tool between the different CL-Net partners. Our World specifically deals with the subject of environmental education, whereas Discover Your Town tackles history learning - and more specific the Middle Ages - at a primary school level. Although the latter is, in contrast with the other applications, content-fixed, it still is an open environment: e.g., the pupils can add documents to the database and insert new pictures and written information.

4 Technological dimension

All software is cross-platform accessible via the Internet, except the Discover Your Town part of the Discover Your Town/Our Castle application, which is an interactive multimedia tool. Current open technological standards have been taken into account in the design process of the applications. E.g. WebKnowledge Forum works alongside a WWW server and can be accessed over network (TCP/IP) through traditional web browsers like Netscape or Microsoft Explorer. Users can remotely login to the databases and use various forms of hypertext commands to read and/or respond to others' notes. The information is saved on a server. Each note is stored on the server instead of being downloaded to the user's machine. This means that teachers and students always have access to the same information on their accounts, regardless of what client machine they use. Minimal requirements for using WebKF are: a 13 inch or larger colour monitor; an IBM-compatible computer or any Macintosh; operating system Windows 3.1, 3.11, 95, NT or Mac 7.1 or higher; at least 8 megabytes (Mb) of RAM memory; an internal or external hard disk with 30 Mb free disk space; and internet access. Requirements for the client version are: a client/server environment with a network or TCI/IP and a computer with Mac OS 7.5 or Windows 95 with 16 Mb of RAM. KF can be licensed for logins from clients using Macintosh, Windows 3.1, 3.11, 95 and 98. Users on all these platforms can connect to the same system, without the problems associated with multiple systems that may or may not be 'linkable'. The Windows Knowledge Forum Client requires a Pentium processor, 32 MB free RAM and Windows95. The Server requires a Pentium processor, windows95, 32 MB Ram and backup storage of the machine. The more the capacity of the server the quicker response times to connected users.

Conclusion

In this chapter, a concise overview of the software used in the CL-Net project is presented. Since the project is oriented towards the enhancement of co-construction of knowledge, its description represents not so much the mere technological or idiosyncratic software characteristics, but the need for synergy between didactical, structural, functional and technological dimensions. Indeed, the collaborative learning environments refer to different approaches of interaction with software, while they equally represent some common features.

In the CL-Net project, communication is at the core of all software development and use. Dependent upon the very concrete goals and tasks, the software differs as to (a) content, (b) curriculum and (c) target group characteristics. For example, WorkMates has been a common tool for information delivery and communication, used by the research group for exchange of documents and project-bound information. Our World and Discover Your Town/Our Castle are instances of highly content oriented and multimedia software, referring to both different groups of children and specific curriculum content. CSILE and KF are consistent with the notion of ‘co-construction’ of knowledge, using very open software to support cooperation and collaboration in many subject-matter domains, like arithmetic and literacy. The quality of this software highly depends upon the quality of both the information put into the database and the concomitant support offered by teachers and peers.

From the outcomes of descriptive-empirical research, it is evidenced that the different software characteristics influence its use made by youngsters in order to attain specific goals. Consequently, the CL-Net research clearly points to the intrinsic interaction between environmental characteristics (software type) and the activities and processes of users, induced by the software. This interplay between environment, curriculum and learners seems to indicate paramount research questions of the future. Not the isolated characteristics of software, but the way it is embedded in a complex context seems to elicit specific outcomes or effects. Consequently, research on instructional design cannot be restricted to the development of ‘isolated’ software but requires more complex interaction studies.

3.2 DESCRIPTION OF MEASUREMENT INSTRUMENTS

Henny van der Meijden

Introduction

The main aims of evaluation in the CL net project were: evaluation of cognitive, metacognitive and motivational effects of the learning environment, in which educational technology is used to help create a community of learners who build knowledge together. Based on different kinds of software packages, a number of experiments was executed. Different measurements were used in the CL net project to collect data: questionnaires, protocols, videotaping, audiotaping, students' productions in the databases, and cognitive tests. Table1 gives an overview of the measurements used in the different countries.

	Belgium	**Finland**		**Greece**	**Italy**	**The Netherlands**		
		Helsinki	**Oulu**		**Bari/Rome**	**Nijmegen**	**Amsterdam**	**Wageningen**
Test site								
schools	1	1	1	1	5	1	3	5
classes	4	1	2	2	8	6	3	groups
level	primary	primary	primary	primary	primary	higher sec.	primary	Second. vocational
students	85	21	56	52	118	142	45	75
age	10-12	10	12		9-12	13-16	10-12	18-24
teachers	4	1	2		6	4	3	7
domains	mathema tics	environ ment	science literature	science	history	biology history science	mathematics	agriculture
Experiments								
within classes	+	+	+	+	+	+	+	+
between classes	+					(1x)	+	
international	+						+	
software	WKF	CSILE	CSILE	WKF	discover/ our world	WKF	WKF	WKF
Measurements								
motivational	+	+	+			+	+	+
cognitive	+	+	+	+	+	+	+	
metacognitive	+	+	+		+	+	+	+
videotaping	+	+	+		+	+		
audiotaping					+	+		
interviews	+	+			+	+	+	+
database	+	+	+	+	+	+	+	+

Table 1. overview measurements

The goal orientation and motivational beliefs questionnaire (all countries)

The item pool to be used as a basis for constructing measurement instruments was based on an integrative account of action-theoretical and goal-theoretical perspectives on motivation (Niemivirta, 1998). An item pool consisting of 67 items was constructed that incorporated various aspects related to student motivation. Scales, example items, and brief descriptions of each dimension are displayed in Table 2.

Scale	*Example item*	Description

Action control	*Even if I don't find a solution to a problem at once, I keep on trying hard.*	Perceptions of the ability to facilitate the enactment of context-adequate intentions whenever it is appropriate
Need for cognition	*I prefer to do something that challenges my thinking abilities rather than something that requires little thought.*	An individual's tendency to engage in and enjoy effortfull cognitive endeavours.
Goal orientations		Individual's preferences for specific types of desired end-states - goals, outcomes, or consequences
Learning orientation	*To acquire new knowledge is the most important goal for me in school.*	Items referring to students' focus on learning, acquisition of knowledge, and gaining competence
Performance orientation	*An important goal for me is to perform better than the other pupils in my class.*	Items for assessing students' ability- and outcome-related focus and evaluation concerns
Avoidance orientation	*I try to get off with my schoolwork with as little effort as possible.*	Items reflecting students' desire to avoid achievement situations and to minimise the effort and time spent on studying.
Means-ends belief of effort	*You succeed in school if you just try enough*	An individual's beliefs about the extent to which certain classes of potential causes (effort, ability, luck) produce certain outcomes.
Means-ends belief of ability	*If one does not learn things in school, it is due to the lack of abilities.*	
Means-ends belief of luck	*It totally depends on luck how one succeeds in school.*	
Agency belief of ability	*I have the ability and skill needed to learn.*	Individuals expectancies about the extent to which they possesses those certain means.
Self-assessment motive	*If I fail in a task, I like to know the reason for it.*	A tendency to evaluate causes of ones actions and their outcomes.
Self-esteem (global self-evaluation)	*I am altogether quite satisfied with myself.*	Individuals' general self-acceptance or their general positive or negative attitudes toward themselves.
Fear of failure, anxiety	*During classes or tests, I often worry that I do worse than the other students.*	Individuals' concerns about failure and performance in public setting;
Study habits		Students' preferences for certain types "tools" for learning
Meaningful engagement	*While doing homework or reading for a test, I often try to evaluate what I don't understand yet.*	Preference for elaboration and metacognitive regulation
Superficial engagement	*When I prepare for a test, I try to memorise things just as they are in the material.*	Preference for rote learning and memorising

Table 2. Scales, example items, and brief descriptions of motivational dimensions.

Four sets of items were used for the study:
A shorter and simpler version of the full questionnaire was constructed to be used with the younger pupils from Belgium, The Netherlands, Greece, and Italy (35 items).Two modified questionnaires with some scales excluded and some others added were used for the two projects in Finland. The original full questionnaire with some additional items and modifications was used only with two samples in The Netherlands.

The metacognitive questionnaire (all countries)

To analyse metacognitive effects we used a metacognitive questionnaire based on Ligorio and Caravita questionnaire which has been used in a few previous researches (Caravita & Ligorio 1995, Ligorio & Caravita 1994; Ligorio et al. 1993). It is composed by three open-ended questions at the pre-test and five questions at the post-test. At the pre-test, the questions are very general, in fact the context learning is never specified. The first question inquires pupils' perception of the source of knowledge; the second inquires the criteria pupils use to control the knowledge acquisition process, and the third their perception of the significance of communication and exchange of information in knowledge acquisition

Here below are listed the questions included in the metacognitive questionnaire:

Q 1- What do you do when you want to know more about something?

Q 2 - How do you know you really understood something?

Q 3 - Do you think it is useful to communicate with others?

Q 4 –What are the most interesting things you learnt this year in History? (post-test)

Q 5 – What did you do to learn them? (post-test)

Two additional questions were included at the post-test and closely related to project contents. Both at the pre and post-test the questionnaires were administrated by a researcher. The questionnaire was always passed during the school hours. Teachers were asked not to intervene during the whole administration session. No time constrain was given and it was stressed to the students that there was no right or wrong answer and that they were required to answer with their own thoughts. Also they were insured that their answers to the questionnaire would not affect at all their school grades. The average time needed to complete the questionnaire was around 30 minutes. When required, the researcher supplied additional instruction to the students in order to help them filling in the questionnaire.

The idea behind these questions and the accompanying scoring system was that CSCL environments like the ones designed and implemented in the different CL-Net sites, would result in a change in pupils' metacognitive and epistemic beliefs from external or internal into interactive.

This questionnaire was simplified by the Amsterdam researchers for primary school children. In table 3 and table 4 the Dutch version of the questions are shown with the English translation.

Dutch version	**English translation**
1. Wat doe je als je meer over iets wilt weten of leren?	1. What do you do when you want to know or learn more about something?
2. Hoe weet je dat je iets echt begrijpt?	2. How do you know you really understand something?
3. Denk je dat het goed is om met iemand anders over informatie en ideeen te praten? Waarom of waarom niet?	3. Do you think it is good to talk with somebody else about information and ideas? Why or why not?

Table 3. First three metacognition questions of the pre-test and post-test

The metacognition post-test included the three pre-test open questions and the following two open questions :

Dutch version	**English translation**
4. Wat is het meest speciale of interessante dat je dit jaar over rekenen hebt geleerd?	4. What is the most special or interesting you learned this year about arithmetic?
5. Hoe heb je dat geleerd?	5. How did you learn that?

Table 4. Two extra metacognition questions in the post-test

The computer-attitude questionnaire (Belgium)

A questionnaire about pupils' familiarity with, beliefs about, and attitudes towards computers was administered in Belgium test site. The first part of this questionnaire, contained ten informative questions about pupils' familiarity with computers in general, and with Internet in particular. The second part of this questionnaire involved 15 Likert-scale questions asking for pupils' beliefs about and attitudes towards computers and their role in (school) learning. This second part was subdivided in five sub-scales, as shown in Table 5.

(1) Fear of computers	*'I am always afraid to do something wrong'*
(2) Collaboration at the computer	*'When working with a computer, I prefer working alone on the computer'*
(3) Ability at computer use	*'Boys are better at working with computers than girls'*
(4) Interest in the computer	*'I'm not interested in computers'*
(5) (Educational) value of the computer	*'You can learn a lot by working on the computer'*

Table 5. sub-scales computer questionnaire

Classroom observations and interviews

In order to envisage the emergence of collaborative attitudes, such as expressing interest for peers work and thinking by reading messages, asking for opinions, and of collaborative actions, such as reacting to messages, making proposals to share projects, working on other classes ideas, integrating outcomes, observations were carried out in different manners:

- field-notes and audiotapes
- field-notes and video-tapes
- audiotapes of class discussions
-

Documentation was integrated with:

- initial interviews with principals for a description of the test-sites (Italy)
- interviews with students about the program
- interviews with teachers about collaborative work before the start of the project (some countries) and at the end of the project (all countries)

The teacher questionnaire consisted of 12 questions:

1) Could you please briefly give us your definition of collaborative learning?
2) Do you recognise your idea of collaborative learning within the European project you have been involved in?
3) Do you think your participation in the CL-net project has changed your idea of what collaborative learning is?
4) Which are the main difficulties that you have experienced in introducing the new technology in the class and
school activities?
5) What conditions need to be fulfilled to implement computer-supported collaborative learning principles effectively in education in general and in your school in particular?
6) How much do you think the new technology used within the project has stimulated new forms of collaboration
and learning both for your students and you? What evidence do you have to support your claim?
7) What were your expectations at the start of this project? To what extent have your initial expectations been met?
8) How do you evaluate (the quality of) the software that you have used, and the way it has been used in the
classroom? What possible improvements/elaborations in the software do you suggest?
9) How do you evaluate your participation, your role as a teacher in the project? Would you have liked to be more/less involved? Would you have preferred to play a more/a less active role in the development of the

curriculum materials, in the research?
10) Do you intend to use the new technology spontaneously in your daily-life classroom practice next school
year, if the circumstances allow it? And if so, how will you use it?
11) Why did you participate into this European project?
12) How would you define this experience according to the results you found?

Table 6. teachers'questionnaire

Contributions in the database

Protocols of communication s between students have been saved. All students' contributions were collected. In most countries all 'pupil notes' were submitted to a quantitative analysis at the end of the project (how many notes, what length, how many notes read from other pupils). This was followed by a qualitative analysis, in which the content of students' notes was analysed.

Cognitive test

The cognitive effects have been studied mainly using two different kinds of data. Some research teams have studied cognitive effects by looking at the development in the nature of the cognitive exchanges that take place in the computer-supported collaborative learning environment in general. A second manner in which cognitive effects have been investigated in the CL-Net project is by comparing students' performances and solution processes on pre-tests and post-tests dealing with the concepts, techniques, cognitive strategies etc. that constitute the domain-specific content of the lessons for which the CSCL environment was developed. Not all descriptions of the work done in the different test sites contain a report of the cognitive effects.

Summary

In this chapter all measurement tools of the CL-net project have been described. This analytical approach was used to obtain information on the cognitive, metacognitive, and motivational effects of computer supported collaborative learning. In the case descriptions of each country, more detailed information can be found.

3.3 COGNITIVE EFFECTS

Lieven Verschaffel

Introduction

Because of the content-specific nature of cognitive effects, it was impossible to develop a general instrument that would be used in the different test sites involving different curricular topics (biology, physics, environmental studies, mathematics…) and pupils of different ages. This makes an overview of the cognitive effects somewhat more problematic than for the other kinds of student effects reported in this section of the final report. Moreover, because the focus of the CL-Net project was on metacognitive and affective effects of CSCL on students, not all descriptions of the work done in the different test sites contain a report of the cognitive effects.

Hereafter we will briefly review the cognitive effects as they were reported in the different case descriptions from the previous section. Before doing that, we point out that in the present project these cognitive effects have been studied mainly using two different methodologies. Some research teams have studied cognitive effects by looking at the development in the nature of the cognitive exchanges that take place in the computer-supported collaborative learning environment in general. In the review below, this kind of data will be used as evidence of cognitive effects only if the data-analysis is done in such a way that (a) it reveals something about the quality of the domain-specific knowledge or skills being demonstrated in the CSCL environment in comparison to other, non CSCL environments, or (b) it describes how the quality of the domain-specific concepts and skills demonstrated in these computer-supported interactions evolved throughout the intervention. A second manner in which cognitive effects have been investigated in the CL-Net project is by comparing students' performances and solution processes on pre-tests and post-tests dealing with the concepts, techniques, cognitive strategies etc. that constitute the domain-specific content of the lessons for which the CSCL environment was developed.

GREECE

Although the Greece team did some interesting analyses of the cognitive exchanges taking place between pupils in the CSCL environment for science teaching, these analyses do not yield much relevant information about the cognitive effects of their environment because no comparison is made between the CSCL exchanges in the beginning and at the end of the program, or between groups of pupils working with and without the CSCL environment. More relevant for this chapter on "Cognitive effects" is that in the first experiment conceptual change was also measured by comparing the drawings and of the texts about the internal heating system of a house produced by the groups of pupils both at the beginning of the 13-hours intervention and at the end of it. A comparison of students' drawings and notes at both times revealed a considerable change in pupils' answers on three crucial aspects of their understanding of the system (namely: proper pipe connectivity, functionality of oil and water, and functionality of the tank).
With a view to obtain a more detailed view of conceptual change at the individual level (rather than at the small-group level), all pupils involved in experiment 2 received a cognitive questionnaire at the beginning and at the end of the 18-hours intervention. The questionnaire consisted of three open questions related to crucial aspects of the heating system. For the first question a significant increase was found from pre-test to post-test, for the second and third question there was a trend in the expected direction which failed to reach significance. Based on these results, the researchers conclude that while the pupils did not get a better

understanding of heat and temperature as abstract concepts of a formal theory, they improved in using this terminology in an authentic situation, in embedding it in a complex mechanism. According to the teachers of the experimental classes, this was a considerable accomplishment (compared to what they would have expected as a cognitive effect at the end of a series of lessons about the same curricular topic taught in a traditional way).

FINLAND

In the Finnish test sites, where KF was used in the biology and chemistry lessons of upper elementary and lower secondary school students, cognitive data were analysed by classifying the KF notes produced by the students into different categories. The major research perspective was to see how students having different initial motivational orientation (learning orientation versus no learning orientation) coped cognitively with the challenges of progressive inquiry.

This kind of analysis yielded several interesting findings about the relationship between students' motivational orientation (learning orientation versus non-learning orientation), on the one hand, and the nature of their notes (questions, comments, explanations), on the other hand. For instance, in the first testsite it was found that learning oriented elementary school pupils learning biology produced slightly more knowledge that was also more advanced in terms of knowledge building procedures. A similar procedure was followed and similar results were obtained in the second test site, involving secondary school students learning chemistry.

However, because the analysis did not focus on the development of the nature and the quality of these notes throughout the program, nor on how the content-specific aspects of these notes differed from the input of students in a similar course taught without CSCL, it is difficult to draw strong conclusions about the cognitive effects obtained in the Finnish case studies.

Italy ("Our world")

As in the Greek study, the Italian team that worked with "Our world" used a questionnaire that was aimed at assessing changes in children's conception of "environment" as a result of their participation in a CSCL project around "Our world". The major question was to what extent the CSCL environment would lead to a change in this conception from a naive mental representation wherein "environment" is identified considered as a static system with concrete physical places to a more appropriate view wherein "environment" is considered as a dynamic ecosystem. The last stage in this conceptual growth is reached when the student attains a bio-centric view of the system.

A questionnaire consisting of four open questions aimed at unravelling pupils' conceptions of the environment was used. A complex scoring system was used, which allowed the researchers to distinguish a spatial conception of the environment from that of a more abstract entity including different kinds of factors. Analyses were done separately for the two groups of subjects involved in the experiments, namely elementary school children en junior high school children. However, due to some differences in the content and/or the administration of the pre-tests and the post-tests, only for two of the four questions, namely question 1 ("Which is your environment in your thinking?") and question 4 ("Try to write down a definition of environment") the researchers were able to compare pre-test and post-test results statistically. The comparison between pre- and post-test results for question 1 revealed only minor changes in both groups of students, which were even in the opposite direction than from a concrete to an abstract conceptualisation. The researchers provide no explanation for this surprising finding. The results of the fourth question were more in line with the researchers' predictions. Taken as a whole, they conclude that the results obtained from their questionnaire indicate that the CSCL intervention has promoted a growth in the conceptualisation of "environment" by moving students' view from merely spatial and structural views to more complex and functional concepts that may offer the basis for the representation of environment as a dynamical system.

BELGIUM

Whereas in the studies reported so far the cognitive effects involved change in students' conceptions of fundamental concepts from curricular domains like biology, chemistry, physics, and environmental studies, the major cognitive-effects hypothesis in the Belgium study dealt with the effect of a CSCL environment on upper elementary school pupils' skills in solving non-standard mathematical application problems. This hypothesis was translated into the prediction that pupils' scores on a word problem-solving test (WPT), consisting of ten unfamiliar and very difficult word problems, would be significantly higher during the post-test than during the pre-test.

As expected, there was a significant raise of the overall results from pre-test to post-test. More specifically, the mean performance of the pupils from the four experimental classes increased from 2.4 on 10 for the pre-test to 4.4 on 10 for the post-test. A comparison of this increase with the increase in score on the same test by the experimental and control group obtained by comparable groups of pupils in another recent design experiment (Verschaffel et al., 1999), indicated that the increase obtained in the experimental classes was substantially higher than what can be normally expected after a similar amount of time of under traditional instructional conditions. However, the two sixth grade classes made a much greater progress (from 3.0 on the pre-test to 6.0 on the post-test) than the two fifth grade classes (from 1.8 on the pre-test to 2.7 on the post-test), which seems to indicate that the cognitive effects of the CSCL environment were much greater in the older age group than in the younger one.

These objective results about the effects of the CSCL environment on pupils' skills in solving non-standard mathematical application problems were confirmed by the comments of the teachers of the four experimental classes, who reported both in their logbooks and in the final evaluative meeting with the researchers a considerable progress in the way (some of) their pupils approached unfamiliar multi-step word problems, not only in the CL-Net lessons but also in the regular mathematics lessons.

CONCLUSION

Putting together the results from the different test sites wherein cognitive effects were measured and reported, the findings seem to confirm the results of the evaluation studies comparing CSILE and non-CSILE classrooms obtained by Scardamalia and Bereiter and their coworkers (Scardamalia & Bereiter, 1998) showing significant advantages for CSILE classrooms on standardised test scores for curricular domains like language and mathematics, but also on process-oriented measures like quality of question-raising and depth of explanation. The important additional finding provided by the CL-Net project is that these positive cognitive effects can also be obtained in non-laboratory settings or at least in settings that are representative for the 'habitat' of most European teachers and pupils in the late nineties.

However, it should be acknowledged that compared to what is reported in Scardamalia and Bereiter's evaluation studies, the cognitive effects obtained in the CL-Net project are rather small. Moreover, the positive conclusions with respect to the cognitive effects drawn at the end of some case studies are sometimes jeopardised by a number of methodological problems (such as the use of non-validated measurement instruments, the absence of a control group…). Nevertheless we consider them as additional evidence that it is possible and feasible to significantly contribute to upper elementary and lower secondary school pupils' conceptual and cognitive development by means of CSCL systems, even in settings where the technology-based support is still rather small and where teachers and pupils are relatively unfamiliar with systems for CSCL like KF and with the constructivistic learning pedagogy underlying them.

3.4 METACOGNITION AND ITS RELEVANCE IN THE CL-NET PROJECT

Beatrice Ligorio

INTRODUCTION

Metacognition is viewed as the ability to think about one's own knowledge and experience of learning and it has been recognized as an important factor supporting learning (Brown 1978; Brown et al. 1993, DeJong 1992), mediating conceptual change (Chi et al. 1981; Gunstone et al. 1992) and monitoring of cognitive process such as memory, language, problem-solving and perception (Flavell, 1979) In this project metacognition is specifically viewed as children's awareness of the learning process, composed by:
- Inquiring sources considered as knowledge 'container',
- Monitoring the comprehension, the achievement of the learning process.
- The perception of communication as a further learning process.

Each of these aspects has theoretical fundaments. About the first two points, it is implied that children's awareness of their active participation in the construction of their knowledge grows together with their ability to interact with a range of different information sources, with the practice of discussing the 'what', 'why' and 'how' learning occurs (Brown et al. 1993). Students equipped by these types of abilities are often defined as '*active learners*' (Brown & Campione 1994; Caravita & Ligorio, 1995). Communication and collaborative strategies enhance students' reflective thinking abilities (Wertsch 1985). Nowadays more and more projects are dealing with the design and the implementation of educational environments where children are actively involved in exchanging information and comments, recursively revising texts, shared tasks, also with the support of new technologies (for an overview see Lehtinen et al. 1999, or chapter 3). The focus in such projects has shifted from the individual to the social construction of knowledge and learning is viewed as an activity 'situated' in the context (Lave 1991; Lave & Wenger, 1991).
In particular in this project metacognition is considered as an additional layer supporting the development of a community where knowledge construction is considered as a social process. All the available tools, including teachers, technology, as well as the intervention of the researchers, are intended to foster higher order thinking abilities (Brown & Campione 1994; Campione et al. 1992, Pontecorvo 1990; Scardamalia & Bereiter, 1993).
CL-Net is aimed at analyzing several educational environments, different in a lot of respects (see Chapter 4 for CL-Net sites description) but having in common the intention of developing a knowledge building communities.

THE QUESTIONNAIRE

The metacognitive questionnaire used in this project to inquire metacognition has been tested in a few previous researches (Caravita & Ligorio 1995, Ligorio & Caravita 1994; Ligorio et al. 1993). These researches have been conducted in different countries (Italy and United States) and administered in several schools with different teaching styles (transmissive versus innovative) and different settings (traditional versus technology oriented). The results gathered during the previous researches leads to the following conclusions: the questions included into the questionnaire effectively inquire what they were designed for, kids from 7 years old on are able to understand the questions included into the questionnaire, also kids with poor writing skills are able to express their knowledge about the questions posed, the answers collected mirror the class atmosphere, answers to the metacognitive questions are

related higher level of thinking that are more influenced within in a longer span of time (2-3 years).
The version of the questionnaire used for this project is composed by three open-ended questions at the pre-test and five questions at the post-test. At the pretest, the questions are very general, since the learning context is never specified. In contrary, the two additional questions included in the post-test are closely related to project contents.

RESULTS

Each country involved in the project collected different data due to differences generated by translation and adaptation of the questions. For this reasons results will be presented separately and a comparison will be made based on the conclusions of each case study.

ITALY

Sample, sites, and software.
The Italian project has two different samples (see Italians reports): students using a piece of software called 'Discover Your Town' within the curricula of History, students using 'Our World' that is focused on Educational Environment.
The first software is based on a multimedia game about the Middle Age and a web site fostering the collaborative construction of Middle Age castles. The second software provides a database where information produced and collected by the pupils can be stored, categorized, discussed, and reciprocally revised. Both of them promote communication and exchange of information among all the Italians sites involved, dislocated in two towns (Rome and Bari). The questionnaire has been administrated also to a control group.
Administration procedure. The general procedure was followed and only in one case the researcher did not achieve to prevent teacher intervention that kept suggesting to the kids how to answer.
The questionnaire was filled in more or less 1 hour and in almost all the case they students did not find the questions to difficult. Only in one case the students (Junior school in Bari) needed more instruction. Their general low educational level explains that.

Specific hypothesis. It is inquired whether relevant differences will appear comparing answers gathered by the more contextualized questions (see questions added to the post- test) and that collected through the more abstract questions used at the pre test. Further analysis on the two additional post- test questions will also considered as indicator of the effectiveness of the project at a metacognitive level.
It is also hypothesized that the comparison between the two software will highlight different metacognitive changes within the samples. Based on the two software's features, it can be assumed that the knowledge sources and the type of monitoring fostered may be different. In fact, the two software differ on how they structure the task: in one case ('Our world') the task is very open and it implies outside class activities, in the other case ('Discover your town') the task is more structured and, although some outside class actives are included, it is designed mainly taking in account guide-lines from the national History curriculum, they may shared the same effect on the communication process. This is in fact a common point between the two software: both of them offer specific tools for the communication with other schools and all the activities designed around them take in account the partner at a distance.

Results.

Results here presented include:
descriptive analysis of the frequencies distribution of the starting point,
statistical analysis:
1) pretest versus post- test comparison,
2) control versus experimental groups comparison,
3) comparison between the two software,
4) analysis of specific answers at the post- test,

Descriptive analysis

How the answers at the questionnaire are distributed is an interesting information, behind any consideration related to the project. It is interesting to have a general overview of what students of this project use as knowledge sources, how they monitor their own understanding and how they perceive the communication process.

In the figure n. 1 all the answers given at the pre-test by the whole sample (History an Educational Environment) are collapsed. It is quite evident that:

- knowledge sources are mainly external;
- only a small percentage (16%) of the sample use a large quantity of sources;
- the knowledge monitor is both internal and external sources but rarely combined (31%);
- the communication is always considered as useful but rather (68%) as a social process.

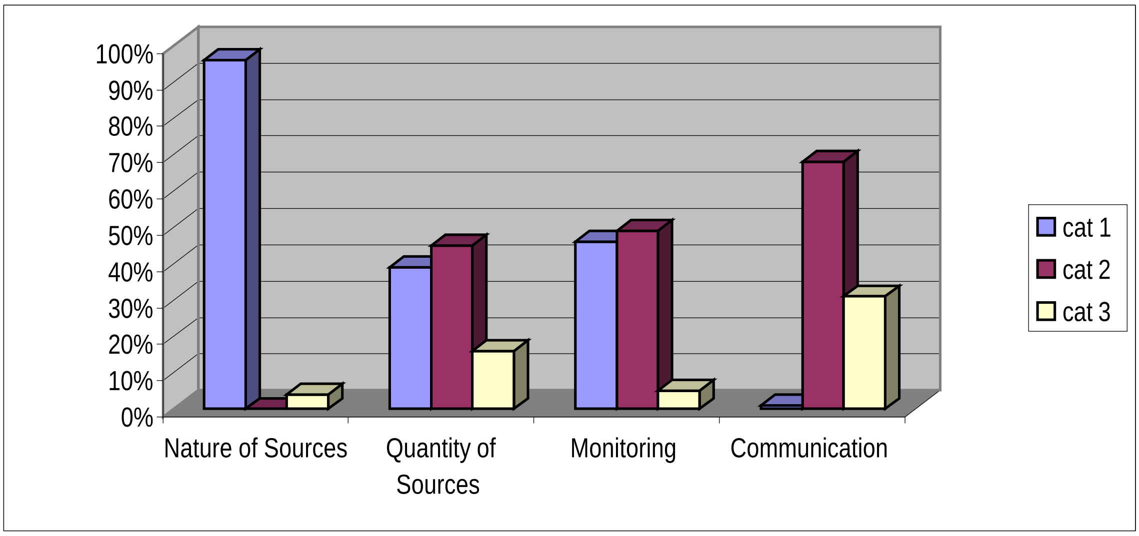


Figure 1: Description of the categories distribution in the whole sample

A finer analysis of the type of external sources quoted at the first question gives an overview of where the kids think the knowledge is located. Each pupil could quote as many sources as he/she wanted and all the sources mentioned were categorized into eight categories:

Source 1: computers and the Internet
Source 2: parents/family/ relatives
Source 3: classmates/friends/other peers
Source 4: teachers
Source 5: books/encyclopaedia/vocabulary
Source 6: experts
Source 7: miscellaneous. Other external sources such TV, radio, ect…
Source 8: not specified (others, adults, people)

In figure n.2 the percentages of each category quoted at the pre test is presented. From the graph it is clear that books and printed materials are still the most used knowledge sources (38%). Experts are almost never quoted and computers and the Internet have a very low percentage (5%).

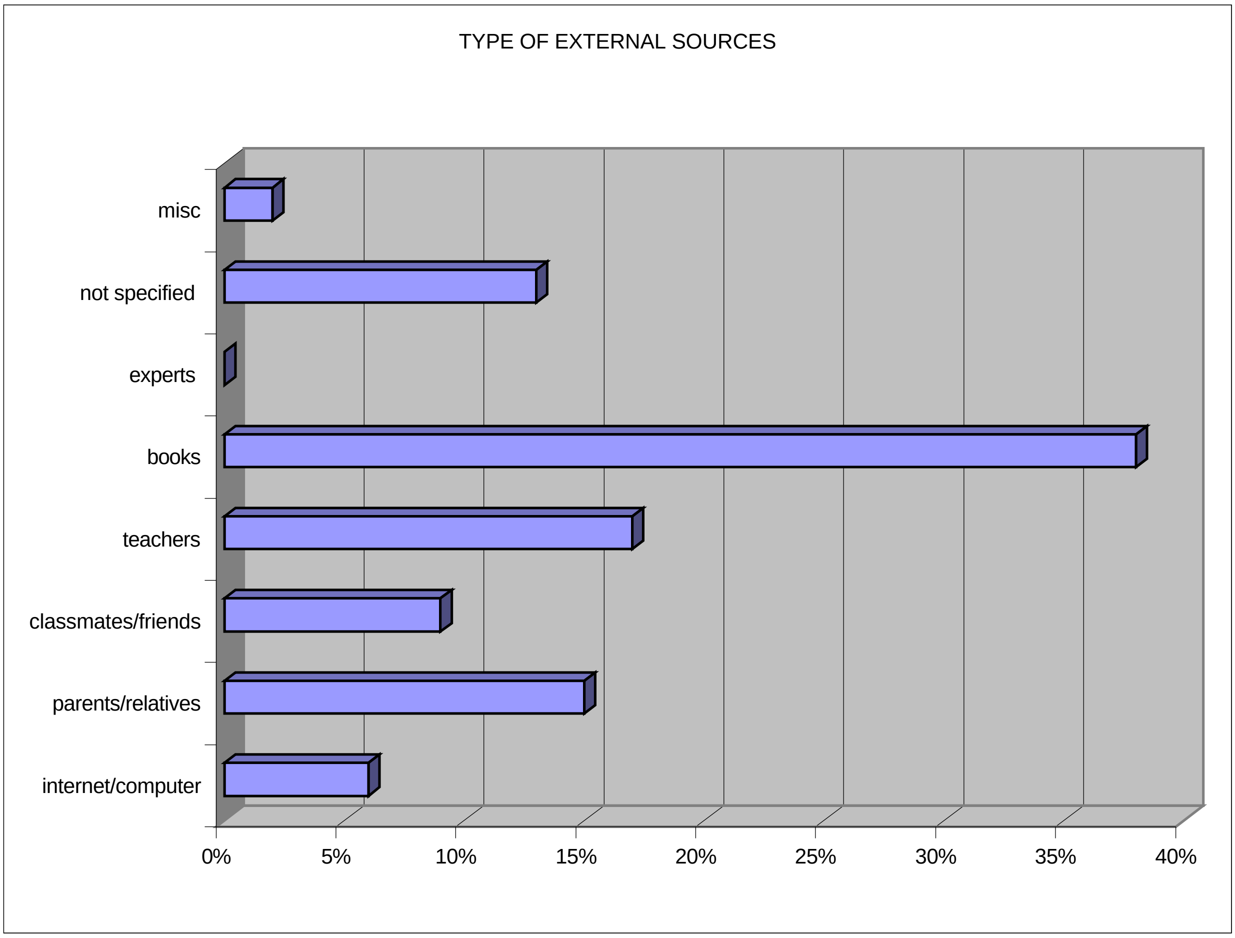


Figure 2: Type of external sources quoted at the pretest by the both sample collapsed.

STATISTICAL ANALYSIS

First of all, it is important to note that no significant differences are reported at the pretest between the experimental and the control groups. The comparisons presented in this section are based on the Chi 2 test and only the significant results are reported. Each of the questions contained into the questionnaire is considered as an observed variable and the answers categories are treated as the levels of each variable.

1) pre versus post- test comparison. No significant differences are observed between the pre and post- test for the control group. About the experimental group, in this comparison the two experimental samples (Educational Environment and the History) are tested separately.
In the sample using the 'Our world' software, within the curriculum of Educational Environment, two variables are significantly different when the pre test (treated here as expected frequencies) is compared to the post- test. The first variable is about the knowledge monitoring, as displayed in the table 1.

  Observed (Post-test) N Expected (Pre-test) N Residual external 17 42.5 -25.5 internal 60 41.5 18.5 combined 13 6.1 6.9 Total 90	Test Statistics monitor Chi-Square 31.487 df 2 Asymp. Sig. .000

Table 1: Chi 2 comparing pre versus post- test knowledge monitoring in 'Our world'

At the end of the project the monitoring has become more internal. In fact, this category records more frequencies at the post- test while all the other categories decrease their frequencies.

Q 2 - HOW DO YOU KNOW YOU REALLY UNDERSTOOD SOMETHING ?

Category assigned	**Answer**	**Researcher's Comments**
Cat 2 - Internal sources	Ferrini, VD RM IT – pretest: *'I really understand something when I can figure that out and I can summarize it in my mind*	Those are typical answers given by the Italian children about the monitoring process. Form them the monitoring is essentially internal and does not change at the post- test
	Ferrini, VD RM IT – post- test: *'When I am sure of it 100%'*	

Cat 3 - Combined/mixed sources	Ferraironi IV A – RM IT – post- test: *'I ask if my opinion in correct. If it is correct I'll try to remember it, if it is not correct I start asking or looking for new information'*	This type of answer is not really frequent in the Italian sample but there is a significant increase of them at the post- test.
	Ferraironi IV A – RM IT – post- test: *'I can understand whether I really understood when I compare my considerations with other friends'*	

Table 2: Sample of answers collected at the 2nd question.

The second variable with a significant change is the communication process. Based on the descriptive analysis, the category 1 of this variable (Communication not useful) it has been drop out since its low frequency in both pre and post- test. The Chi 2 has been run on the other two categories and a significant difference has been recorded comparing pre and post-test.

Observed (Post-test) N Expected (Pre-test) N Residual exchange 53 71.8 -18.8 learning 37 18.2 18.8 Total 90	Test Statistics Communication Chi-Square 24.334 df 1 Asymp. Sig. .000

Table 3: Chi 2 comparing pre versus post- test communication in 'Our world'

Comparing the frequencies at the pre test (expected) to that at the post- test (observed) it is clear that the first category (communication as a social process) decreases, while the second category (communication as a learning process) increases: at the post- test communication is more perceived as a learning process.

Also the sample exposed to the '**Discover your town**', used in the curriculum of **History**, has two variables with significant differences between pre and post- test. The first variable is about the number of sources quoted by the students (see table 4).

Observed (Post-test) N Expected (Pre-test) N Residual Mono 34 17.3	Test Statistics N. of Sources Chi-Square 33.418 df 2 Asymp. Sig.

16.7 medium 19 41.6 -22.6 large 13 7.1 5.9 Total 66	.000

Table 4: Chi 2 comparing pre versus post- test number of sources in 'Discover your town'

The second variable affected at the post- test is the communication perception, as described in table n.5.

  Observed (Post-test) N Expected (Pre-test) N Residual social 32 57.5 -25.5 learning 34 8.5 25.5 Total 66	Test Statistics communication Chi-Square 87.556 df 1 Asymp. Sig. .000

Table 5: Chi 2 comparing pre versus post- test communication in 'Discover your town'

The communication process at the post- test is perceived more as learning strategies. The increase of the frequency in this category is quite considerable.

The similar result about the changes in the communication perception mirrors the commonality between the two pieces of software: both of them enhanced communication with external partners, located in schools of the same town, schools in the other Italian town as well as in the other countries taking part to the project. Here below are presented some answers to the third question selected from the pre and post- test from which is clear how the communication perception has changed during the project.

Q 3 - DO YOU THINK IT IS USEFUL TO COMMUNICATE WITH OTHERS? WHY?

Pretest	Post- test
Ferrini, VD Rome IT – pretest: *'Because it may be that the others know more stuff that I know and talking with can exchange them. In this way we can accumulate a lot of information'*	Ferrini VD RM IT post- test: *'Because explaining it to other I can learn more'*
Ferrini VD, Rome IT – pretest*:* '*Yeas, I think it can be useful because we can tell each other ideas and compare them without saying any thing to the teacher'*	Ferrini VD, Rome IT – post- test*:* *' Because in this way everybody knows to know something'*
Ferrini VD RM IT pretest: *'Because it is nice, funny and you may found new friends'*	Ferrini VD RM IT post- test: *'Because if someone doesn't know something or doesn't have ideas after having exchanged information or ides with others you may have more ideas, ideas that you didn't have before'*
Ferraironi IV C, Rome IT - pretest: *'to know the people we are supposed to work with'*	Ferraironi IV C, Rome IT - post- test: *'You can get into the discourse more in depth and you can better understand what information is not necessary and what information is needed, what you have to say and what can the omitted'*

Table 6: Comparing answers from the pre versus post- test about the communication perception.

2) Control versus experimental groups comparison.
Since for both curricula the control group was smaller than the experimental group, the Chi2 test has been run selecting an adequate experimental group.
The results obtained comparing pre versus post- test are confirmed for both samples when the experimental groups are compared to control groups. In fact, the sample using 'Our world' (Educational Environment) is significantly different from the control on the same two variables: monitoring (Chi 2 = 17, df 2, p .00) and communication (Chi 2 22, df 1, p .00). Students on the experimental group relay more on internal monitoring and they perceive the communication more as a learning process.
The sample using 'Discover your town' (History) when compared to the control group confirm the significant differences about the number of sources quoted (Chi 2 = 30, df 2, p 001) and the communication perception (Chi 2 = 71, df 1, p. 00). Those students, compared to their control, show a stronger tendency in quoting multiple sources and the communication is for them a learning process.

3) Comparison between the two software.
Comparing the two software the results gained so far are further more confirmed:
Pupils exposed to 'Our world' have a more internal monitoring, while that using 'Discover your town' show a more equal distribution between the internal and external monitoring (Chi 2 = 26, df 2, p. 001).
The use of 'Discover your town' improves the number of knowledge sources while the students belonging to the 'Our world' tend not to quote more than tree sources at the time (Chi 2 = 31, df 2, p. 001).

4) Analysis of specific answers at the post- test.
At this point the two extra questions added at the post- test are investigated.
The sample using **'Our world' (Educational Environment)** has a significant higher number of answers (63%) quoting the specific issues carried out during the project and the types of sources quoted are strongly related to the project (58%). But the most interesting result appears comparing answers to question n.5 to that gathered by the parallel but more abstract question n.1. The comparison is based on the quality of the knowledge sources categorized with the common decoding system where are distinguished internal, external, and combined sources. It is necessary to note that since the internal category has always recorded a very low frequency, it has been collapsed to the second category. In this way the Chi2 is run only on two categories:
one type of source: external or internal,
combined sources: external and internal.

This method has been used also for the other test run on the first question, but even that the results were not significant.
In this analysis a striking difference is observed: when the question is contextualized within the project the number of combined answers goes from 10% to 22% and this change is very significant (Chi 2 = 25, df 1, p. 0001).

In synthesis:
Issues strongly related to the project are quoted,
Sources introduced by the project are quoted as well,
Knowledge sources are combined when the question is contextualized.

Different results are gained by the sample using **'Discover your town' (History)**. Very rarely the pupils quoted the issues related to the project (10%) and the majority (88%) of the answers collected do not refer to the sources introduced. No differences are recorded when contextualized answers are compared to that generated by first question, where the context was very abstract.

In synthesis:
The issues quoted by the students are not related to the project,
Tools and activities introduced by the project are very rarely mentioned,
No difference is recorded comparing contextualized answers to that more abstract.

Results interpretation.
The results obtained so far allow to confirm the specific hypothesis, in fact:
Both software share the same impact on the communication process. In fact, their common point was the stress on the communication with partners at a distance; each software has specific effects:
Ÿ **'Our world'** raises the internal monitoring and produces more project-sensitive answers at the post- test,
Ÿ **'Discover your town'** increases the number of knowledge sources mentioned by the students and at the post- test the specific related project activities and tools are not mentioned.

A closer look to the answers collected will give an explanation of this result. To understand the different trend shown by those answers the researcher's point of view will be used. In qualitative analysis, such that provide in this project, the researcher's point is considered as a further source of data (Flick 1998).

In table 7 are reported a few answers from the **'Our world'** sample where project issues are quoted. On the left column of the table there are the researcher's comments.

Q 4 – What are the most interesting things you learnt this year in Educational Environment?

Category assigned	Answer	Researcher's Comments
Cat. 3 – CL-Net topics	*'the most interesting it has been to talk to other classes and to other countries'*	The reference to other countries and to the complex concept of 'puzzle' can be considered as a specific effects of the project: both those ideas where never quoted at the pre-test.
	'That every environment is a sort of puzzle where each piece is really important for the surviving of the others'	

Cat 2 - CL- Net sources	*'Exploring the suburb even when I am not in the class'*	This group focused very much on class discussions. Kids at the post- test are quoting the discussion as a tool for learning and to understanding. At the pre-test the discussion was not mentioned at all.
	'Working together, discussing, working on the computer, talking to other classes to see what they think about it'	
	'We did a lot of things but what helped me to learn more were the class-discussions'	

Table 7: Only post--test answers from the **'Our world'** sample.

From these examples is possible to conclude that the topics and activities introduced by **'Our world'** were fully remember by the. Class discussions, out-side class activities to study the environment, and the communication at the distance were very original and new for those students. The students using **'Discover your town'** although exposed to the same new and original activities, still have traditional frontal lessons and standard books**:** History is a traditional topic in school and it seems that even when studied with innovative tools, still keeps its traditional 'flavour'. In fact when looking at the answers given at the 5^{th} questions they still quote traditional sources.

Q 5 – WHAT DID YOU DO TO LEARN THEM?

Category assigned	Answer	Researcher's Comments
Cat 1 - Traditional sources	*'We did it because we had instruction'*	Neither issues nor tools related to the project are quoted. The History curriculum is not a new topic, but instead

	'I learnt from the books and listening to the teachers'	has a strong tradition in schools. This tradition implies that sources to learn History are mainly books and teachers: sources linked to a traditional perception of the curriculum that the project did not replace.

Table 8 : Only post- test answers from the **'Discover your town'** sample.

Students involved in the History curriculum when asked to refer about their way of learning History, they evoke the most traditional setting that, of course, was not fully replaced by the project activities. The History teacher still gave frontal lessons and books are an important part of the curriculum: those are the tools and activities that students refer to while answering to this question. The new activities introduced by the project are just not associated to the question given. In fact, during a class discussion they explain this point to the teacher inquiring them about the answers they gave at the questionnaire.

Teacher: 'None of you quoted the Middle Age? How come? You did not like it? Why none of you mentioned it? '
Kid 1: 'Because we had History up to the Romans'
Teacher: 'And you didn't think to what you did in the computer lab?'
Kid 2: 'The castle!'
Kid 3: 'Discovering your town, the Middle Age'
Teacher: 'so what was it? Wasn't it History?'
Kid 4: 'But that was computer science!'
Kid 5: 'It was Italian because we went there with the Italian teacher'

Educational environment is a new interdisciplinary issues just introduced into the Italian school. Using the label of Educational Environment in the 5th question may had lead the students to concentrate more to the project-based activities, also because such topic was not taught them in other ways.
This conclusion may tell us that effects of innovative projects, such as CL-Net, are more visible when also the curricula introduced are innovative. The interdisciplinary nature of the Educational Environment curriculum fosters a higher awareness of the metacognitive skills here observed. The same can be said about the communication in general: this variable reported always significant effects and that may be because communication is in general a new and original activities for the Italian classes.
In order to have visible effects at the metacognitive level, new activities and tasks have to be designed embedded into interdisciplinary curricula.

THE NETHERLANDS

Sample, sites, and software. In the Netherlands three different sites were involved in three different towns: Secondary education (Nijmegen,), primary education (Amsterdam) and secondary agricultural vocational education (Wageningen). All of them used Knowledge Forum as computer based platform but in different curricula and for different school level (see the national case description). Because those diversities, results on the metacognitive questionnaire will be presented separately.

Administration procedure. In all the sites the questionnaire has been administrated following the standard procedure. In Nijmegen and in Wageningen the metacognitive questions administrated to the pupils were adapted during the translation. The questions actually asked to the students are:

1. When you get an assignment, let's say homework, and you don't know anything about the topic: what do you do to know more about this topic?

2. When you are learning, for example you study for a test, how do you know you really understand the material?

3. Do you think it is useful to exchange ideas with classmates? Do you do this often? In what situation do you do this?
In those two sites the only-post-test questions were not included. The Amsterdam sites used the standard version with also the only-post test questions.

Specific hypothesis. No specific hypothesis are made because, even if the three sites use a common software, there is a diverse set of other variables, such as:
• nature of the curricula
• age of the students
• stress on the communication with other school
• length of the project
• different version of the questionnaire administrated.

Results.
Nijmegen: secondary education (comprehensive school)
The configuration of the data at the pre test in this site is similar to the Italian sites: students tend to use much more external sources, the monitoring is either internal or external, only rarely combined, and the communication is perceived as useful for social aspect and as exchange of information already acquired.
When comparing the pre and post-test the most interesting results found in this site, are about: the 1st question, in particular the type of external sources quoted by the students, the 3rd question inquiring the perception of the communication.

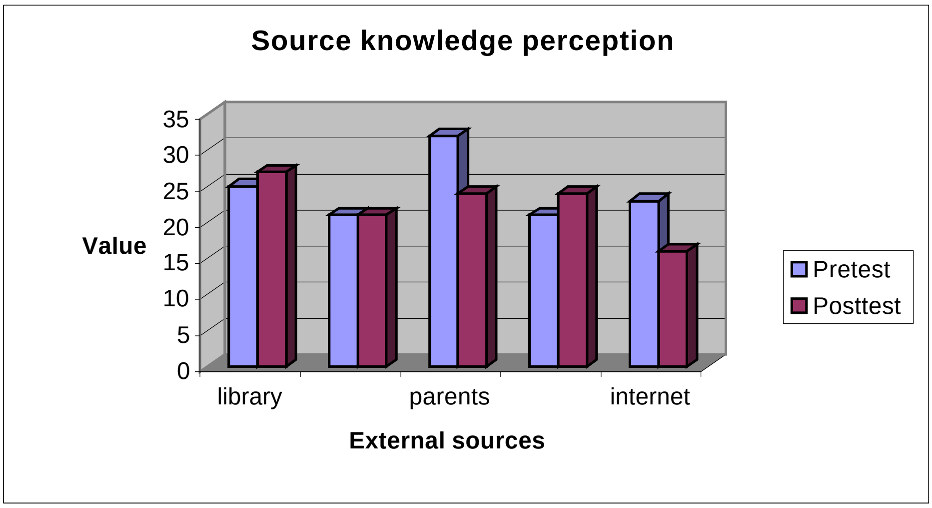


Figure 3: External knowledge sources

Figure 3 shows the various external knowledge sources used by the students and the differences comparing pre- versus post-test. Eye-catching, is the decrease of the Internet as

resource. A reasonable explanation could be the fact that in the evaluation, students point out that it takes a lot of time to find information on the Internet.
About the knowledge monitoring question, a few differences between the pre-test and the post-test were observed. Most of the students score high values on internal style, both at the pre- and the post-test.
The third question of the metacognitive questionnaire, concerning the communication process, reveals a striking difference between the pre-test and the post-test. As is shown in figure 4, students change their perception of communication from as useful for an exchange of information and social aspects, to useful as part of the learning process. None of the students believe communication is not useful.

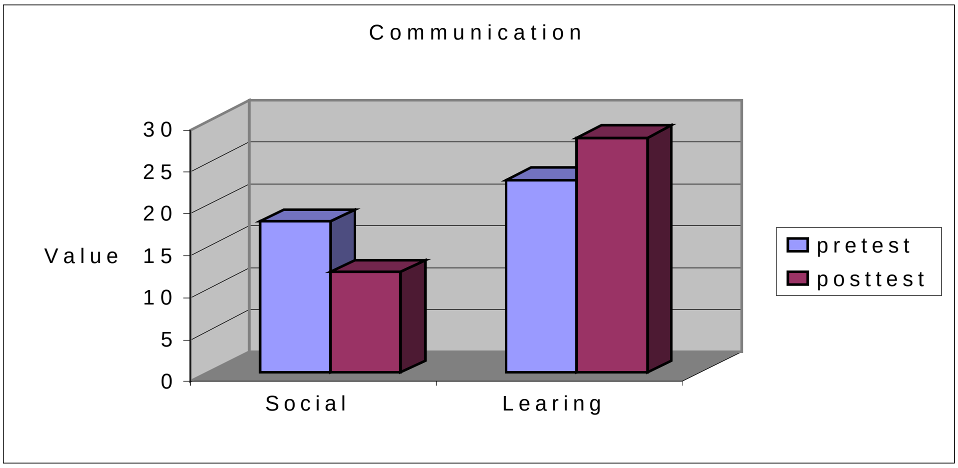


Figure 4: Perception of the communication

The most important part of the communication process takes place during the lessons, sometimes after school, but seldom at home. Figure n. 5 illustrates the communication network. The student finds his partner in the person next to him, or in another classmate. It is surprising that the students never mention the teacher in the collaboration network.

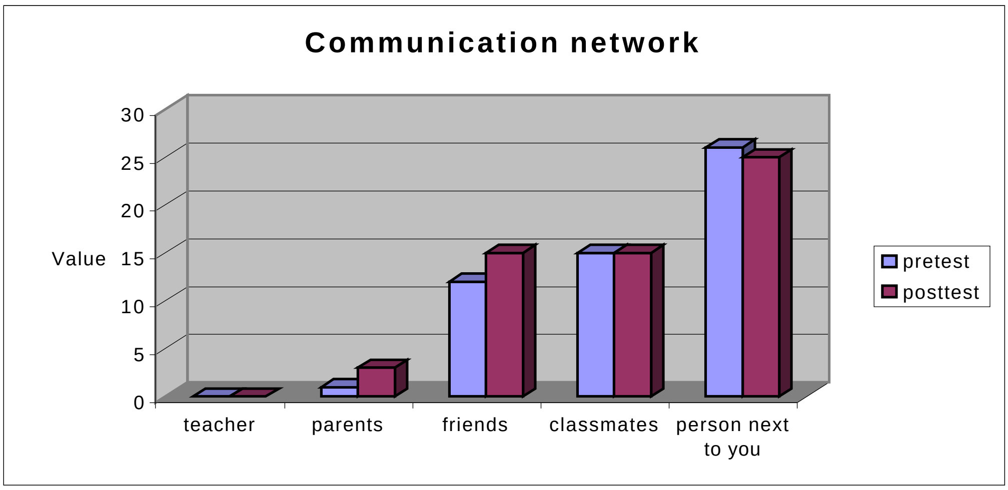


Figure 5: Communication network

AMSTERDAM: PRIMARY EDUCATION

This site, dissimilarly of the other two Dutch sites, has used the standard version of the metacognitive questionnaire. Again the same pattern of distribution of the observed variables is found in this site: pupils mainly look up books or they ask the teacher to improve their understanding, their knowledge monitoring tend to be internal although there are a few combined answers, and the communication process is perceived as exchange of information and as a social process.
When this distribution is compared to the post–test, the most relevant result obtained is about the communication process.

  Observed (Post-test) N Expected (Pre-test) N Residual Not useful 2 .9 1.1 Social 20 24.7 -4.7 Learning 8 4.4 3.6 Total 30	Test Statistics Communication Chi-Square 5.230 df 2 Asymp. Sig. .073

Table 9: Chi2 comparing pre versus post-test communication perception

At the post-test the communication perception as a social process decreases and more pupils see it as a process fostering learning. Only a few of them (2) switched to a negative perception of the communication (see also figure 6).

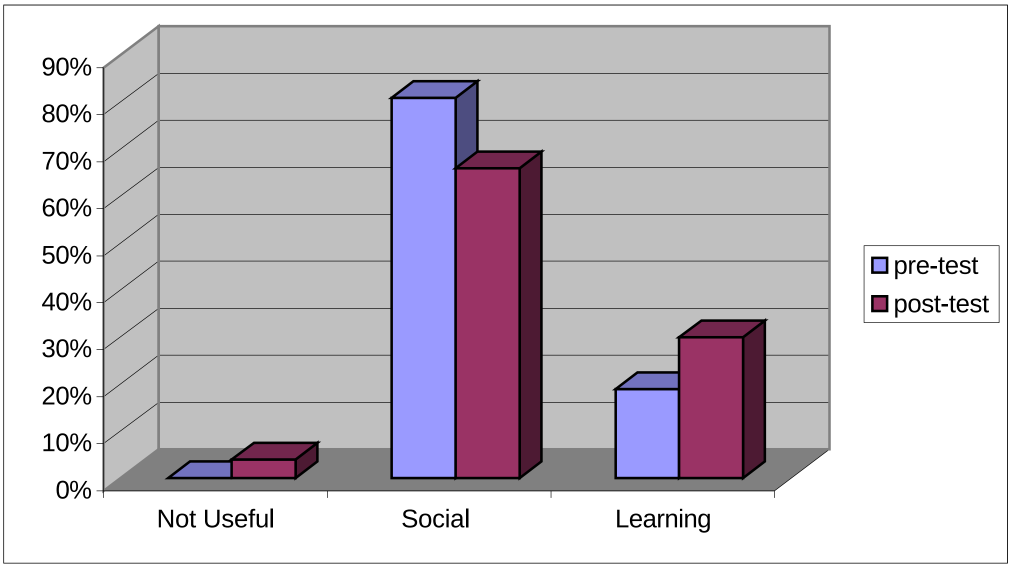


Figure 6: Pre versus post-test comparison of the Communication perceptions.

About question 4 (*What are the most interesting things you learnt this year in arithmetic?)*, three pupils answered quoting the exact topic introduced by the project but all the other answers were closely related to the project activities.

A second significant result is found in this site comparing the more abstract question n. 1 to the more contextualized question n. 5, introduced just at the post-test. When Amsterdam pupils use knowledge sources in a specific context, their preference for external sources decreases. The frequencies in all the other categories increase included that in the non-answer category (see Table 10 and Figure 7).

  Observed (Contextualized Q. 5) N Expected (Abstract Q. 1) N Residual external 16 20.0 -4.0 internal 2 .7 1.3 combined 4 1.3 2.7 Total	Test Statistics quality source Chi-Square 8.800 df 2 Asymp. Sig. .012

22	

Table 10: Chi2 comparing pre versus post-test communication perception

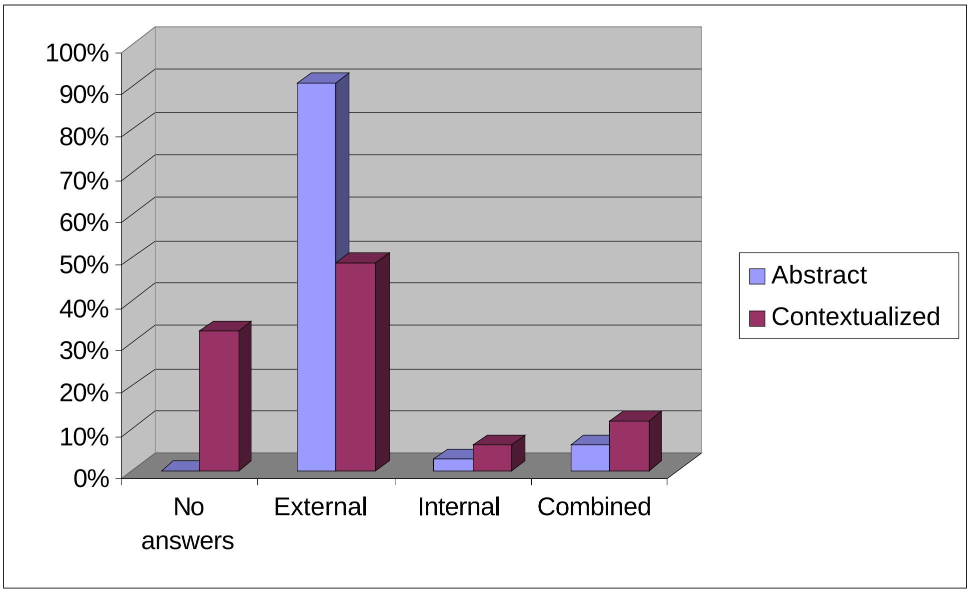
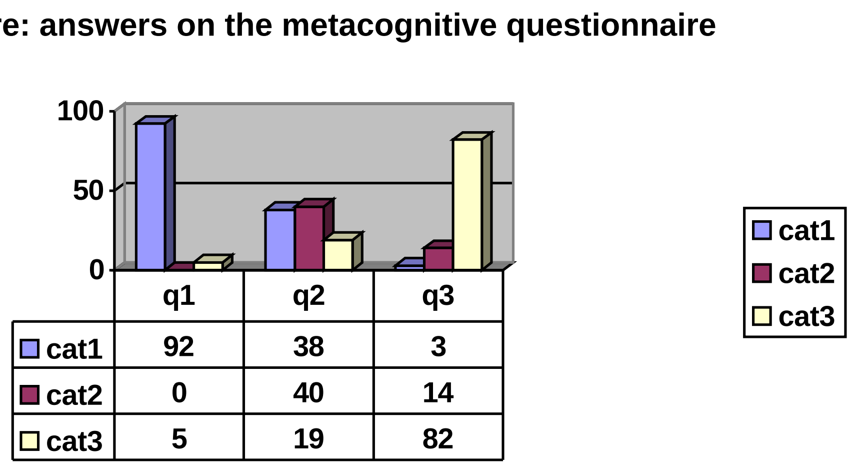


Figure 7: Abstract versus contextualized comparison of the quality of knowledge sources.

WAGENINGEN: SECONDARY AGRICULTURE VOCATIONAL EDUCATION

The same version used in Nijmegen has been administrated in Wageningen. The overall frequencies at the pre-test are summarised in the next figure.



	q1	q2	q3
cat1	92	38	3
cat2	0	40	14
cat3	5	19	82

Figure 8: Distribution of the observed variables at the pre–test

External sources quoted in answers to the first question, are also classified along those categories:
Source 1.1 library
Source 1.2 internet

Source 1.3 parents/family
Source 1.4 classmates
Source 1.5 teacher
Source 1.6 books and encyclopaedia
Source 1.7 miscellaneous

The next figure (n. 9) shows frequency of each type of external sources.

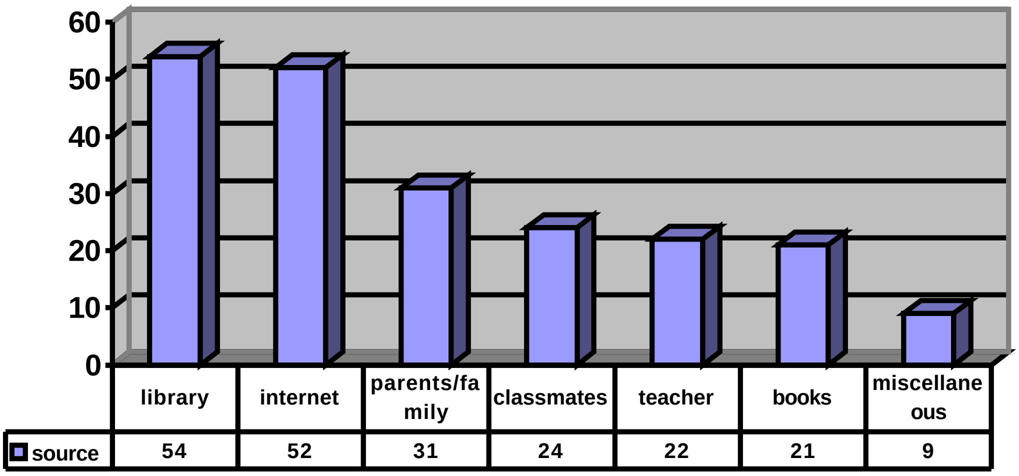


Figure 9: Overview of external sources

The comparison between pre versus post-test shows that:
Question n. 1 (sources of knowledge) showed no difference at all (except for the missing answer)
The second question, regarding knowledge monitoring, showed a greater stress on internal monitoring and unexpectedly a decrease of the interactive category
The third question on whether communication is useful and how it is perceived showed little change (more answers in favour of communication as a learning process and fewer regarding communication with others just for the exchange of information).

The figure 10 shows a visible pattern of the students that tend to are stable in using external sources for new information, increase their internal knowledge monitoring, and perceive the communication more as a learning process.

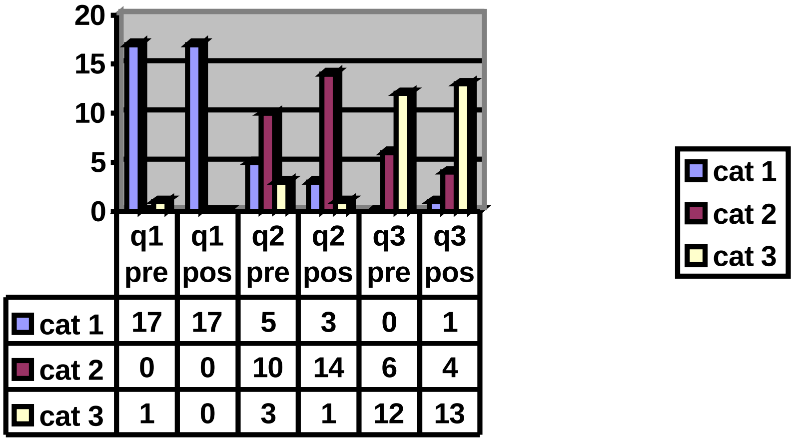


Figure 10: Pre versus post-test comparison

GREECE

Sample, sites, and software. In Greece five 6th grade classes were involved in the project and all of them used knowledge Forum as computer based environment to support knowledge building and communication. For more details about this site see the CL-Net deliverable produced by Kollias, Vlassa, Mamalougos & Vosniadou (2000).

Administration procedure. The standard administration procedure was followed but the answers were categorized through a finer decoding system. Here below are reported the decoding systems and the results for each question. For almost all the questions, significant results have been found when boys and girls were divided into two different samples (see also table n. 11, 12, and 13).

Specific hypothesis. The general hypothesis is inquired and a more specific hypothesis is based on the particular Greece educational setting that seems to be much more traditional then the other countries involved in the project.

Question n. 1

Decoding system:

Reference to computers as possible source (RC)
Number of non-human sources mentioned (NS)
Reference to parents as sources (RP)
Reference to teacher as source (RT)
Reference to other students as sources (RS)

Results.

The answers in the pre and post- tests of the students were compared using the Wilcoxon Signed Rank Test. Only the significant results are shown in the table 11.

Measure	Group	Increase	Decrease	Ties	Significance
Refers to Computers	All students	14	2	44	**.012**
	Boys	9	0	20	**.006**
Number of non Human	All students	20	10	26	**.036**
	Boys	10	4	12	**.067**
Refers To parents	All students	5	12	39	**.090**
	Boys	0	5	21	**.025**

Table 11: Pre versus post-test comparison of knowledge sources distribution.

There is significant increase in the boys only in:
mentioning the computers as sources
using a higher number of non human sources (books, CD-ROM, etc)
not using their parents as sources
Boys seem to be more sensitive to the creation of a richer information environment which gives them the opportunity to explore information sources.
There is no significant difference in both genders in mentioning classmates or teachers. It seems that students, no matter their genders, do not change their searching strategies that are indeed very rooted in the educational tradition of this country.

Question n. 2
Decoding system:

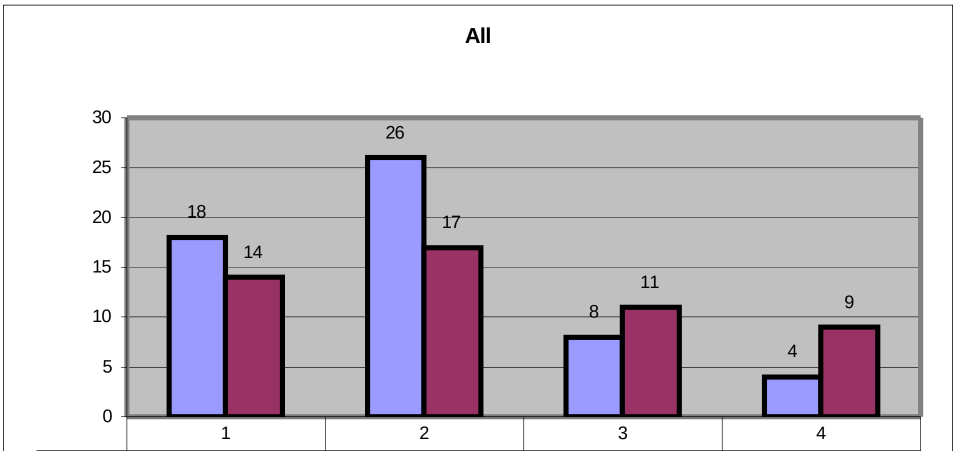
The validation comes from an external source (E.g. When they ask me and I answer right) (External Validation)
The validation comes internally as a feeling (E.g. I just feel it) or there is also a validation strategy mentioned but it is confused with the attainment strategy (E.g. When I think of it many times) (Internal Validation, confused)
The validation comes internally and the validation strategy is mentioned (Eg. When I can tell it by myself, inside me) (Internal Monitoring)
The validation is emerging in a communicating environment (E.g. When I can explain it well and I remember it for a long time) (Communication Enhancement).

Results.
We consider these categories to represent increasing values of a measure of quality in monitoring understanding. For each student we compared their answer in the pre and post questionnaire and noted whether the student's category has increased, decreased or stayed the same (ties). We therefore measured the frequencies of increases, decreases and ties in students' grade on this measure. Table 12 shows the frequencies of changes in the 'Quality of monitoring understanding' construct and their significance.

	Increase	**Decrease**	**Ties**	**Significance**
All students	16	7	28	**0.040**
Girls	10	4	14	**.027**

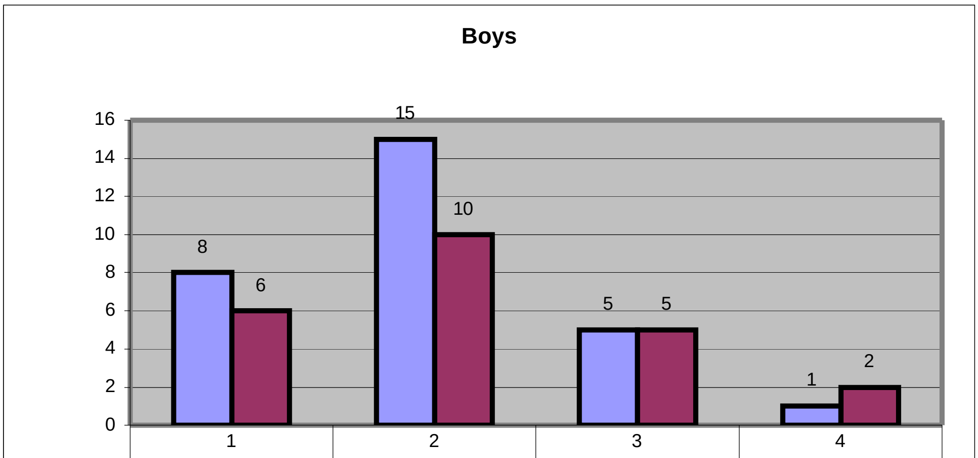
Table 12: Frequencies of changes in the 'Quality of monitoring understanding' construct

Both boys and girls show an improvement in this measure. However this is much more pronounced for girls. The following histograms show the frequencies of answers in the different categories for the pre and post tests (side by side) and for 'All students', 'Boys Only', and 'Girls Only'.



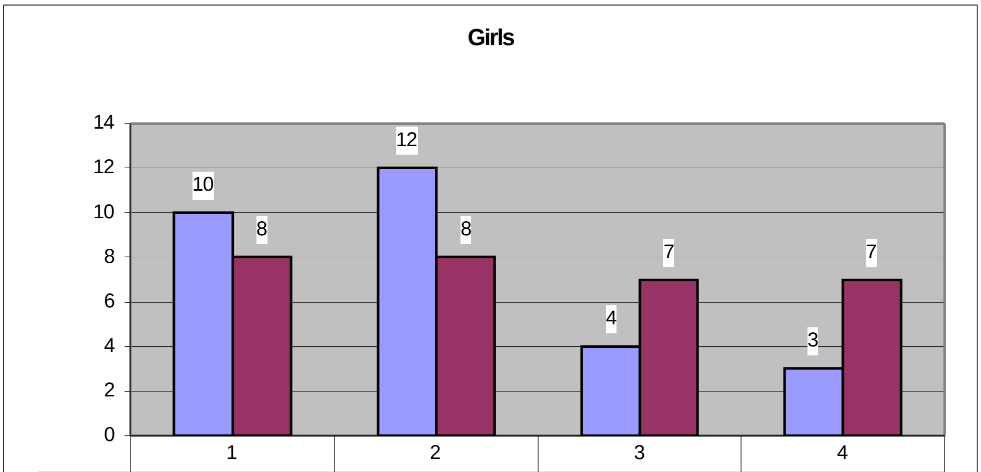
	1	2	3	4
q39a	18	26	8	4
nq39a	14	17	11	9

Figure 11: Knowledge monitoring along the four Greek categories for the entire sample



	1	2	3	4
q39a	8	15	5	1
nq39a	6	10	5	2

Figure 12: Knowledge monitoring along the four Greek categories only for the ‘boys’ sample



	1	2	3	4
q39a	10	12	4	3
nq39a	8	8	7	7

Figure 13: Knowledge monitoring along the four Greek categories only for the 'girls' sample

The gender difference is very stable: the project had a more pronounced metacognitive effect on the boys than on the girls.

<u>Question n. 3</u>
Decoding system:

Whether they saw the exchange of information as something useful to both parties (vs personally useful) (Common usefulness)
Whether they saw information as something to be processed at a deeper level (vs. to be adjoined to whatever was previously known) (Deep Processing of Information)(E.g. we learn more things vs. because if we synthesize more things we can make something nice).
Results.
No significant differences are revealed in this question.
FINLAND
Sample, sites, and software. The questionnaire used in the Finland included the first three questions common to all participant countries but only the test site of Helsinki administered the questionnaire both at as pre- and post-tests. 21 primary school students (age 10) used Knowledge Forum for a four-week period of progressive inquiry project. The domain of the project was biology. More details about this site are available in the CL-Net deliverable produced by Rahikainen, Salovaara, Järvelä , Lipponen, Lallimo , Syri & Niemivirta (2000).

Administration procedure. A research assistant administered the pre and the post- tests metacognitive questionnaire and she stayed with the children until everyone had completed their answers (in the pre test, there were two researchers assistants present). The teacher was always present in the classroom while the tests progressed. In the post- tests some students did not have enough time to answers because a special requests from the teachers.

Specific hypothesis. This site does not have any specific hypothesis and the general once will be inquired.

Results.

The overall result of the metacognitive evaluation is that there are not many significant changes between the pre and the post- tests, which confirmed the preliminary expectations. The knowledge source perception was most commonly external and at the post- test this was the only category found. Knowledge regulation was nearly as often external as internal. Only in the third question some changes could be observed. In the post- test, communication was experienced as being useful more often when the knowledge was in progress; also fewer students in the post- test felt that communication is not useful at all (Chi2 test, p<.01). Most of the students felt that communication is useful, although still at the post-test the most common alternative was exchanging of final results.

Replies given in the first question are also analysed more in carefully. How many different knowledge sources children mentioned in their pre and post- tests were counted and no significant differences could be observed. Equally many knowledge sources were mentioned before and after the project as shown by figure 14.

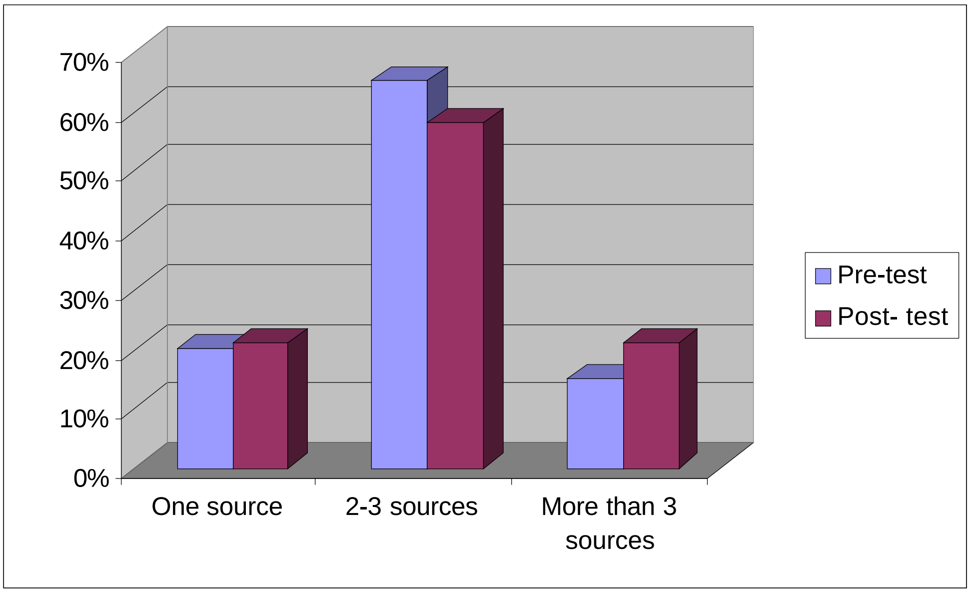


Figure 14: The number of knowledge sources mentioned by children.

Some typical answers (translated from Finnish) will show more clearly the Finnish students' conceptions about different metacognitive aspects. As a reply to the question 'What do you do when you want to know more about something?', one child said that *'I ask my teacher and other students. I may also use the www or search in books. As a rule, I can find the information quite easily. For example in our research on asteroids I found a great www site when my father helped me.'* In the 2nd question, the external and the internal categories emerged as approximately equally numerous. One student whose knowledge regulation was internal answered *'Generally if I have understood the thing I can explain it in many ways. If I have not comprehended it, it will remain in my mind in the same form as in the text.'* Another student who represented external knowledge regulation answered *'If my task has been performed correctly*.' In the third question the commonest alternative was that exchanging of final results is useful, which is seen in this example: *'If there are 2 groups giving a speech on the same topic and the first group finds 50 pages information but the other cannot find any then the first group can inform the second one.'*

BELGIUM

Sample, site and software:
Two fifth-grade classes and two sixth-grade classes used the WebKF-based learning environment. There was no control group involved. The kids used the platform within the arithmetic curriculum. For more details about this site, see the CL-Net deliverable produced by Verschaffel, De Corte, Lowyck, Dhert & Vandeput (2000).

Administration procedure: The questionnaire was administrated in all classes at the same time by the four teachers and one researcher from the University of Leuven. The teachers were given a written protocol and an oral explanation of the administration procedure. The teachers were told very clearly they should not intervene, because of methodological reasons. The metacognitive questionnaire was linked on the motivational questionnaire and all pupils were free to spend as much time as needed to fill in both questionnaires. Most pupils completed the questionnaires in less then one hour.

Specific hypothesis. No specific hypothesis is available.

Results.
In Leuven only the first three questions of the questionnaire were analyzed. The other questions (the 2 extra post-test questions) were not analyzed systematically because of the fact that many children did not complete them. Nevertheless, some impressions from the analysis of the answers on these two questions will be reported.

QUESTION N. 1

Both at pre- and post-test, almost all the answers were coded as ‘external sources’ and some changes are recorded in the distribution of the frequencies, as synthesized in the following figure.

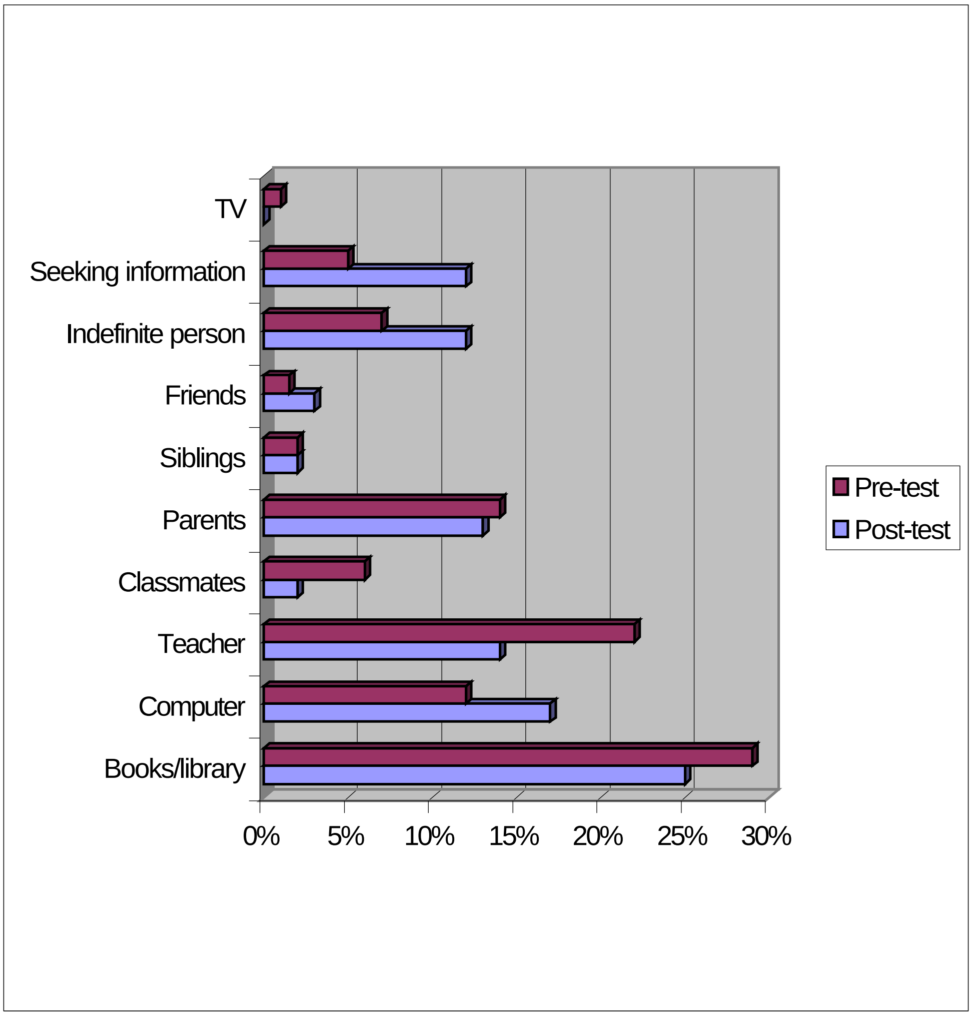


Figure 15: Comparing external sources at the pre- versus post-test.

Question n. 2

Both at the pre and post-test knowledge monitoring is clearly internal and no significant changes are visible, as shown in the figure here below.

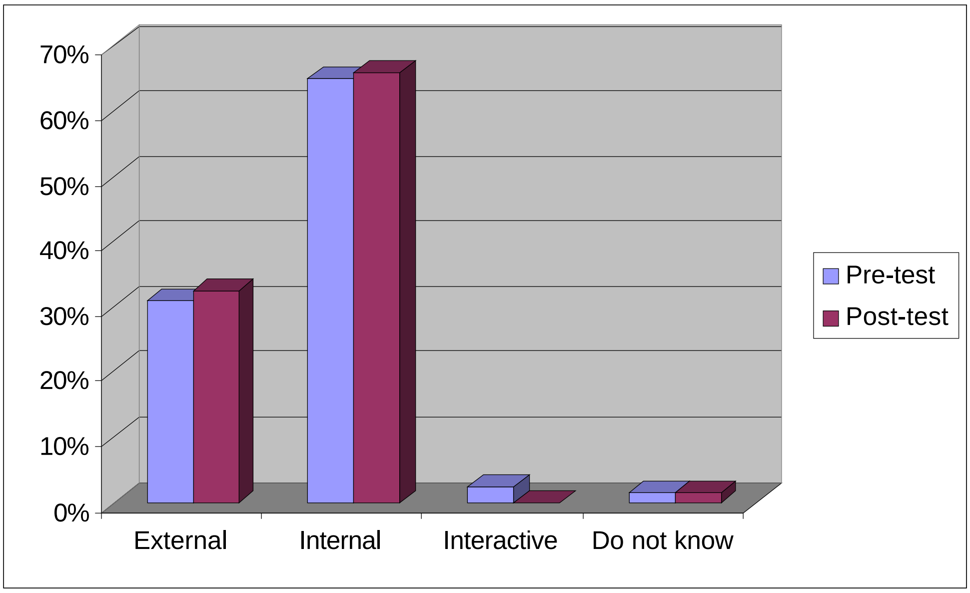


Figure 16: Comparing knowledge monitoring at the pre- versus post-test.

<u>Question n. 3</u>

Answers here collected are scored with the following system coding:
positive: yes, I think it is useful;
negative: no, I don't think exchanging information is useful;
do not know (DNK).

Most of the pupils react positively at the pre-test as well as during the post-test. The difference recorded between the two testing phases does not allow concluding that the project had an impact on this variable.

CROSS-COUNTRIES COMPARISON

All the countries involved in the CL -Net project share a pretty similar distribution of the variables observed at the pre-test. That is:
- the sources used to improve the knowledge are mainly internal
- the knowledge monitoring tends to be either internal or external
- the communication in prevalence perceived as a social process, useful to exchange information and to establish relationships.

Although differences in terms on each variable are observed, at the end of the project the communication perception changed in most of the sites. This result suggests that the communication perception is the most sensitive variable to be impacted by a project like this. Also we learn from the Nijmegen case that pupils relate the communication process more to the out-side class. This could be an additional explanation to the higher impact on this variable.

About the different impact on the other variables some conclusion can be taken based on the national cases reported.
In order to improve metacognitive skill, it may be not enough to introduce a computer-supported learning environment. The nature of the issues introduced should change as well, in

a way that may be more sensitive to innovation. In fact, in Italy a difference between traditional and innovative, multidisciplinary curricula have been experienced.
More traditional learning environments may impact in a different degree depending on the gender of the pupils. In fact, in Greece boys were able to change their attitude towards the knowledge sources while girls change more their style of knowledge monitoring.

Also, in order to have better cross-national comparison, it is recommended, in further European projects, to better standardize the translation and adaptation of the tools, to agree on a common decoding system, and to use similar statistical test for the analysis of the data.

3.5 AN OVERVIEW OF THE MOTIVATIONAL MEASURES

Alessandra Talamo, Markku Niemivirta

Introduction: theoretical rationale and general aims

Much of the research on modern learning environments have focused on the interaction between students and the environment they operate in and with (see Schauble & Glaser, 1996). Yet, even though the aim usually has been to explore possibilities for fostering both individual and collective engagement in learning activities, individual differences within the learning space are often ignored. However, we do have a reason to believe that the way students perceive both opportunities or challenges within the learning environment are in part dependent on their prior experiences and personal beliefs (cf. Järvelä & Niemivirta, 1999). Research suggests that students' interpretations of the affordances provided within the context may vary as a function of their motivational orientations and attitudes, and that these interpretations influence the way they get involved with subsequent classroom practices. In line with this argument, an attempt was made in this project to take into account some aspects of such individual differences in motivation.

The item pool to be used as a basis for constructing measurement instruments was based on an integrative account of action-theoretical and goal-theoretical perspectives on motivation. The core idea of this framework is that students' activity in a learning situation is guided, supported, *and* constraint by their goals, beliefs, and expectations about one's ability to control and to successfully execute actions and to thereby influence the environment (Mischel, Cantor & Feldman, 1996). Furthermore, it is argued that students can be characterized in terms of their predominant motivational orientations and the distinctive organization of the interrelations among them and the psychological features of the situations (cf. Boekaerts & Niemivirta, 2000).

Grounding on these assumptions, two different research perspectives can be adopted. One focusing on students in terms of their beliefs and actions, and another focusing on the social context and its constituents. The former can further be approached from either a variable-oriented perspective, which emphasizes differences and relationships among the variables of interest, or from a person-oriented perspective, which stresses individuals' (or groups') value profiles on the given dimensions (Bergman, 1998; Niemivirta, 1998a). Studies utilizing the variable-oriented perspective on individual differences in motivation have found, for example, that learning orientation (e.g., goal of increasing competence) is related to high self-efficacy and self-reported use of elaborate learning strategies, whereas performance orientation (e.g., goal of demonstrating competence) is related to anxiety and self-reported use of surface-level strategies (for reviews, see Pintrich, 1999; 2000). Furthermore, more recent work have demonstrated how different types of goal orientations and motivational beliefs also contribute to students' situation-specific perceptions and experiences, and through such appraisals, influence their subsequent performance in various types of tasks (Niemivirta, 1999a; 2000).

In a complementary manner, studies following the person-oriented approach have shown that students with different types of motivational profiles differ in many respects: they have different views of themselves as learners (Niemivirta, 1998a); they have different types of beliefs about factors that contribute to learning and school achievement (Niemivirta, 1999b); they report preferring and using different types of learning strategies and study methods (Niemivirta, 1998b); and they differ with respect to the type and quality of task-specific goals they set for themselves (Niemivirta, 1999c).

Finally, studies taking into account the social context and the characteristics of the learning environment have found that not only do differently motivated students perceive their learning environments differently and prefer different types of instructional practices (Peltonen & Niemivirta, 1999), but they also seem to engage in different types of activities during classes and study projects (Hakkarainen, Lipponen, Järvelä, & Niemivirta, in press). There is also some preliminary evidence that new pedagogical cultures and instructional practices may well have a positive influence on the goals students adopt and the learning activities they engage in (cf. Järvelä, Niemivirta, Hakkarainen, 2000).

Despite the different foci, these briefly described perspectives cannot be considered as alternatives, but rather as complementary approaches, which mostly build on each other. In line with this notion, the first step of the present project was to conduct a basic descriptive analysis of the individual differences in motivation within and between the participating countries. Accordingly, we sought to (1) examine the evolution of pupils' self-reported motivational dispositions in the course of each project, and (2) explore some possible motivational trends and patterns of differences (or similarities) among the participating countries. Due to the overall nature and characteristics of the project (e.g., relatively short time span, implementation in a 'real world' setting) 'true' experimental designs were not possible to employ. Because of this, each site specified their own research aims and focused on aspects relevant to their particular project. Therefore, no overall assumptions were made with regard to changes over time or differences between groups. However, we believed that the results would (1) help us to distinguish groups of students in terms of the mind frame with which they approach school work in general, and thus (2) provide a frame of reference against which to interpret site-related findings between and within the participating countries.

INSTRUMENTATION AND PROCEDURES

Following the theoretical framework briefly presented above, an item pool consisting of 67 items was constructed that incorporated various aspects related to student motivation. Scales, example items, and brief descriptions of each dimension are displayed in Table 1.

Scale	*Example item*	Description
Action control	*Even if I don't find a solution to a problem at once, I keep on trying hard.*	Perceptions of the ability to facilitate the enactment of context-adequate intentions whenever it is appropriate
Need for cognition	*I prefer to do something that challenges my thinking abilities rather than something that requires little thought.*	An individual's tendency to engage in and enjoy effortful cognitive endeavors.
Goal orientations		Individual's preferences for specific types of desired end-states - goals, outcomes, or consequences
Learning orientation	*To acquire new knowledge is the most important goal for me in school.*	Items referring to students' focus on learning, acquisition of knowledge, and gaining competence
Performance orientation	*An important goal for me is to perform better than the other pupils in my class.*	Items for assessing students' ability- and outcome-related focus and evaluation concerns
Avoidance orientation	*I try to get off with my schoolwork with as little effort as possible.*	Items reflecting students' desire to avoid achievement situations and to minimize the effort and time spent on studying.
Means-ends belief of effort	*You succeed in school if you just try enough*	An individual's beliefs about the extent to which certain classes of potential causes (effort, ability, luck) produce certain outcomes.
Means-ends belief of ability	*If one does not learn things in school, it is due to the lack of abilities.*	
Means-ends belief of luck	*It totally depends on luck how one succeeds in school.*	
Agency belief of ability	*I have the ability and skill needed to learn.*	Individuals expectancies about the extent to which they possesses those certain means.
Self-assessment motive	*If I fail in a task, I like to know the reason for it.*	A tendency to evaluate causes of ones actions and their outcomes.
Self-esteem (global self-evaluation)	*I am altogether quite satisfied with myself.*	Individuals' general self-acceptance or their general positive or negative attitudes toward themselves.
Fear of failure, anxiety	*During classes or tests, I often worry that I do worse than the other students.*	Individuals' concerns about failure and performance in public setting;
Study habits		Students' preferences for certain types "tools" for learning
Meaningful engagement	*While doing homework or reading for a test, I often try to evaluate what I don't understand yet.*	Preference for elaboration and metacognitive regulation
Superficial engagement	*When I prepare for a test, I try to memorize things just as they are in the material.*	Preference for rote learning and memorizing

TABLE 1. SCALES, EXAMPLE ITEMS, AND BRIEF DESCRIPTIONS OF MOTIVATIONAL DIMENSIONS.

FOUR SETS OF ITEMS WERE USED FOR THE STUDY:

A SHORTER AND SIMPLER VERSION OF THE FULL QUESTIONNAIRE WAS CONSTRUCTED TO BE USED WITH THE YOUNGER PUPILS FROM BELGIUM, THE NETHERLANDS, GREECE, AND ITALY. SINCE THESE SITES ALSO WANTED TO HIGHLIGHT DIFFERENCES IN SOME AREAS THAT CHARACTERIZE CHILDREN'S WORK IN RELATION TO THE LEARNING CONTEXT FOSTERED BY THE CL-NET PROJECT, THREE ADDITIONAL SCALES WERE INCLUDED. THESE DIMENSIONS DEALT WITH THE SOCIAL CLIMATE CREATED INSIDE THE CLASS WHEN WORKING IN A COOPERATIVE WAY. THE FINAL SHORT VERSION OF THE QUESTIONNAIRE THUS INCLUDED 25 ITEMS TAPPING VARIOUS DIMENSIONS OF MOTIVATION (I.E., NEED FOR COGNITION, LEARNING ORIENTATION, PERFORMANCE ORIENTATION, MEANS-ENDS BELIEFS OF EFFORT, MEANS-ENDS BELIEFS OF LUCK, FEAR OF FAILURE, AND SUPERFICIAL ENGAGEMENT) AND 11 ITEMS CONCERNING PUPILS' PERCEPTIONS OF SOME SOCIAL ENVIRONMENTAL ASPECTS LINKED TO THE COMMUNICATIVE CONTEXTS THAT THE PROJECT WAS SUPPOSED TO ENHANCE SUCH AS COLLABORATING INSIDE THE CLASS AND AT A DISTANCE, AND THE EXPOSITION TO A WIDER RANGE OF INFORMATION SOURCES AND PERCEPTIONS OF SOCIAL CLIMATE (DISTANCE INTERACTION WITH OTHERS, USE OF VARIOUS INFORMATION SOURCES, AND MOTIVATION FOR WORKING WITH CLASSMATES).

TWO MODIFIED QUESTIONNAIRES WITH SOME SCALES EXCLUDED AND SOME OTHERS ADDED WERE USED FOR THE TWO PROJECTS IN FINLAND. THIS WAS MAINLY DUE TO THE FACT THAT A GREAT DEAL OF PRIOR WORK HAD BEEN CARRIED OUT FOR SOME TIME, AND IT WAS THEREFORE SENSIBLE TO CONTINUE WITH SAME INSTRUMENTS. THE ORIGINAL FULL QUESTIONNAIRE WITH SOME ADDITIONAL ITEMS AND MODIFICATIONS WAS USED ONLY WITH TWO SAMPLES IN THE NETHERLANDS.

SUMMARY OF THE RESULTS

IN ALL CASE STUDIES, THE QUESTIONNAIRES WERE SUBMITTED BOTH AT THE STARTING POINT AND AT THE END OF THE PROJECT. ALTHOUGH THE PROCEDURE FOR THE ASSESSMENT HAD BEEN ESTABLISHED FOR ALL THE RESEARCH GROUPS, SOME DISPARITIES WERE STILL FOUND IN THE WAY EACH SUB-PROJECT CARRIED OUT THE SURVEY. THESE DIFFERENCES WERE MAINLY DUE TO THE VARYING CONDITIONS IN EACH TEST-SITE. IN THE FOLLOWING, WE WILL FIRST PRESENT A BRIEF SUMMARY OF THE RESULTS REPORTED IN EACH CASE STUDY. AFTER THAT, WE WILL PRESENT A COMPARATIVE ANALYSIS OF THE DATA CONSIDERED EQUIVALENT ACROSS THE PARTICIPATING SAMPLES. FINALLY, SOME GENERAL CONCLUSIONS WILL BE DRAWN OF THE OVERALL FINDINGS AND FEW SUGGESTIONS WILL BE PRESENTED CONCERNING THE POSSIBLE NEXT STEPS.

RESULTS OF THE CASE STUDIES

GREECE

THE GREEK RESEARCH GROUP REALIZED AND ADOPTED A GREEK TRANSLATION OF THE SHORT VERSION OF THE QUESTIONNAIRE IN THREE PRIMARY CLASSES. FOUR DIMENSIONS WERE EXTRACTED FOR THE ASSESSMENT PURPOSES: NEED FOR COGNITION; PERFORMANCE ORIENTATION; FEELINGS THAT THE OTHER STUDENTS HELP; AND ATTITUDE TOWARDS INTER-CLASSROOM COLLABORATION. THE FIRST TWO OF THESE DIMENSIONS ARE RELATED TO THE CHALLENGE OF SCHOOL WORK, AND TO THE EFFORT THAT THE STUDENTS ARE ASKED TO PUT IN FOR THE DEVELOPMENT OF SCHOOL TASKS, WHILE THE OTHER TWO ARE EXPLICITLY REFERRED TO THE PERCEPTION OF THE ROLE OF COMMUNICATION AND PEER HELP IN THE LEARNING environment. Although the results showed no marked overall differences over time, some indications were found suggesting that the students displayed less interest and excitement in problem solving and related activities at the later measurement point. However, this effect appeared to be in part a function of gender that is, girls seemed to decline more than boys. Moreover, girls also showed more decrease in performance orientation than boys and more experience of peer. In sum, although the decrease in various scores could relate to a general methodological bias (e.g., an 'excitement effect' produced the intervention at the beginning of the study), it is likely that also changes in school practices contributed to the findings. As suggested in the case report, increase in out of school activities might well be considered as an influential factor. The Greek study also points out the importance of considering inter-individual differences when evaluating project outcomes; for instance, their findings suggest a possibility for a relationship between gender and task challenge versus relational orientation.

Belgium

As the project was held in primary classes, the short questionnaire was applied here as well. The Belgian research group carried out a project on mathematical problem solving and, for this, focused their motivational and attitudinal analysis on aspects that seem to be more related with problem solving (e.g., challenge of learning difficult topics). As in both the Italian case studies, some findings on the perception of the relevance of a collaborative social climate inside the class show an increasing tendency in the post test.

Italy (The «Our World» project)

Here the shorter version of the questionnaire was used both for primary and junior classes. In this case study the concept of the survey of motivational effects is still relevant. An exploratory analysis of the data lead to the inclusion of three dimensions: performance orientation, outcomes of learning process, and superficial engagement, respectively. Different results emerged from the comparison between pre- and post-test data for primary and junior high schools. However, these were not explained from a developmental perspective, as changes due to age, but as differences between the classes in terms of the environmental organization of the learning process either as a starting point or at the end of the Our World project. With respect to the social climate, this case study showed a tendency towards an increasing preference for collaborative contexts and a decreasing one for solo activity. These results have been interpreted as effects of the project on the perception of learning environment in terms of positive considerations for social interaction.

Italy (The «Discover your town » project)

This study shows in practice some emblematic points of this kind of research. The short questionnaire was submitted to both primary and junior high schools. A factorial analysis lead to four dimensions pertaining to motivational beliefs and two related to the consideration of social interaction. Here the developmental hypothesis had been tested by using control groups both in the pre- and in the post-testing, but even then, the problem of comparing classes arises already at the starting point: the pre-test comparison either between experimental and control classes, or between experimental classes themselves, showed different patterns of responses. Even after adjusting to these disparities, the main results concerning the post-test comparison between experimental and control classes showed a significant difference in interest in distance interaction: compared to the control classes the experimental classes showed a greater consideration for distance interaction as a resource for learning. Again, this result was interpreted as an effect of the interactive activities that had been developed within the project.

FINLAND

Compared to the others, the Finnish group used the motivational data in a slightly different way. Students were first categorized based on their motivational tendencies, and then analysed in relation to their actual classroom activities by means of observations and on-line interviews. In this case, motivation has been interpreted not as an outcome of the project, but as a facilitator that contributes to students' approaches to classroom engagement. The aim was thus to explore how students' with different types of dispositional tendencies interact with the learning environment. Specifically, the study shows how motivational dispositions (and learning orientation, in particular) relate to the way students face learning tasks. Of specific interest here is the finding that the employment of a new pedagogical culture may well enhance task-oriented engagement and facilitate effective collaborative efforts among the pupils. However, some indications were also found suggesting that the increasing challenges new instructional practices and technology bring about may result in excessively high perceived demands by some less-motivated pupils.

The Netherlands (Amsterdam case study)

In this study, the preliminary analyses showed a decline in most motivational dimensions (even in the socially non-desirable domains). As in the Greek study, this might be due to a general "intervention-effect", but - as suggested in the case report - also due to some administrative issues (e.g., time of assessment). Nevertheless, the only statistically significant effect was found for superficial engagement, which might reflect genuine changes in pupils' approaches to learning. More detailed analyses are required in the future in order to verify the validity of this interpretation.

OTHER CASE STUDIES

At present, the motivational data from the remaining two projects (case studies from Wageningen and Nijmegen) are still under elaboration. Due to the limited psychometric information available about the motivational outcomes extracted from these studies, any conclusions would clearly be unwarranted. Preliminary information and analytical descriptions for both studies are found in respective case reports.
In general, the results obtained in the case studies suggest no robust effects that could be considered as a common finding across the individual projects. Two reasons could explain the fact that not many changes were found in the first place: either there genuinely were no changes or the measurements themselves were not sensitive enough to capture them. Indeed, considering the time span of each project the methods applied might have not tapped the most appropriate level of measurement. However, as pointed out in the beginning, the main focus here was to provide descriptive information to be utilized in further stages of analysis. Despite these methodological concerns, some rather consistent evidence were nevertheless found suggesting that during the course of the project many students showed less emphasis in superficial engagement and more interest in collaboration. This possibility alone can be considered as an encouraging outcome.

RESULTS OF THE COMPARATIVE ANALYSIS

The purpose of this section is to provide an overview of the cross-cultural differences (or similarities) found in motivational measures. The goal was *not* to consider any motivational ‘effects’ *per se*, but to rather explore the possibility of some general trends (e.g., degree of stability and change) in pupils’ motivational scores across the groups and over time. This was done by first examining the extent of construct comparability across groups (i.e., how similar the measurements were) and then comparing disattenuated mean levels among the samples. Although the same item pool was used as the basis for constructing country-specific motivational questionnaires, the adopted translations were not fully comparable. This was mainly due to differences in language, site-related relevance, and/or culture-specificity in item contents. Thus, for the present purposes, only items that were considered comparable in terms of item content were used for the analyses. Furthermore, to avoid sample-related bias in the results, only groups comprising of pupils of similar age were included.

The analyses were carried out in two steps. First, in the exploratory phase, the conceptual structure of the item set was examined for each group by means of exploratory factor analyses and item analyses. Items that exhibited poor psychometric qualities within any of the groups or which seemed to behave very differently across the groups, were excluded. For the second phase - the examination of construct equivalence and latent mean differences - only items that did not function differently in any of the samples were thus included. The final set of samples, scales and corresponding items are shown in Table 2.

Samples
Belgium (N=80)
The Netherlands (N=50)
Greece (N=68)
Italy (N=191)
Scales and items
Learning orientation (LO1, LO2, LO3)
Need for cognition (nCog1, nCog2, nCog3)
Means-ends beliefs of luck (MebL1, MebL2, MebL3)
Failure concern (FC2, FC3, FC4)

Table 2. Samples, scales and items included in the final analyses.

Covariance structures analysis is well suited for examining construct equivalence because it permits corrections for measurement error and simultaneous model fitting of an hypothesized factorial structure in two or more groups. Furthermore, since in a latent variable system the construct (latent factor) is believed to have a causal influence on the observed variables. Covariance structures analysis allows the estimations of disattenuated factor means, and, in the case of multigroup analysis, tests for group-level differences. The prerequisite for such an analysis is, however, sufficient level of measurement equivalence.

Measurement equivalence exists at several different levels (see Horn & McArdel, 1992). If manifest variables load on the same latent variables across groups, and if the factor loadings are not significantly different, then factorial invariance is said to exist (cf. Byrne, Shavelson, Muthén, 1989). A higher level of measurement equivalence exists if, for example, the variance-covariance matrices of the error terms are not significantly different. However, factorial invariance is the necessary condition for comparisons across groups (Bollen, 1989).

If the results of confirmatory factor analyses (CFA) permit the conclusion that sufficient configural and factorial equivalence exists across the groups, the logical next step is to examine the degree of measurement invariance and differences in latent means across the groups. This is obtained by extending the analyses to include means and variable intercepts in the model (Byrne et al., 1989; Little, 1997). The simultaneous estimation of covariance and mean structures associated with the latent and observed variables facilitates the ultimate goal of making inferences about the groups' population means on the construct of interest. In other words, group differences on the observed variables are presumed to be the direct result of group differences on the underlying construct, and this can be assessed through structured means analysis (SMA).

Due to space limitations, the results of the above mentioned analyses are presented here very briefly. The analytical procedure was carried out in following steps:
First, *each group* was analysed as follows:
Separate CFAs for pre- and post-test data
Separate SMAs for pre- and post-test data
Multigroup SMA for full data

After this, if the fit of the model was adequate for each set of data, the *whole sample* was analysed as follows:
Separate multigroup CFAs for pre- and post-test data
Separate multigroup SMAs for pre- and post-test data
Multigroup SMA for full data
Based on the group-level analyses (steps 1 to 3), a common factorial model was specified (see Figure 1). The overall fit of the model was then tested as described above (steps 4 to 6). Group-level analyses suggested that the six items intended to measure learning orientation and need for cognition in fact loaded on one single factor. Thus, as illustrated in Figure 1, the final model included three correlated factors: task orientation (TO), means-ends beliefs of luck (MEBL), and failure concern (FC), respectively. It was also found that two items reflecting need for cognition shared variance that was not explained by the common factor. Therefore, the error terms for these items were allowed to correlate.

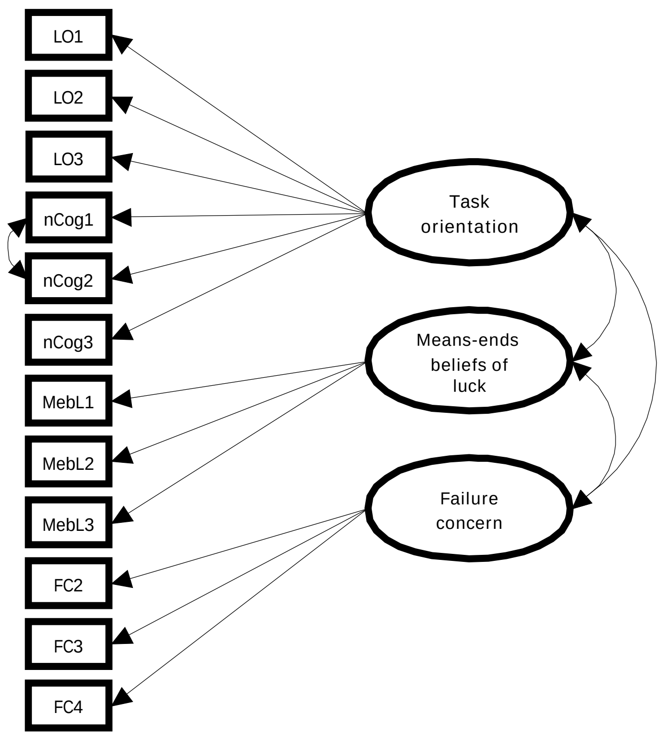


Figure 1. The final measurement model.

Steps 4 and 5 suggested that an invariance model - a model in which all loadings and intercepts are fixed invariant across the groups - did not fit the data well. Accordingly, the following items and corresponding intercepts were estimated freely across the samples: LO1, LO2, nCog1, nCog2, and MebL3. This shows that of the three factors specified, only means-ends beliefs of luck and failure concern could be considered as fully comparable across the groups *and* over time. The overall fit for the corresponding model was good (? ^{2}(456) = 481.47, p = .20; CFI = .95, NNFI = .94, RMSEA = .024).[2] Since it was now possible to estimate a model that fit the data for each group, the next step was to compare disattenuated latent means. This was done by fixing one group at a time as a reference group, and then comparing the latent mean differences of the other groups against the reference group. As mentioned before, the strength of this approach is in its power to correct the estimates for measurement error and take into account differences, for example, in group-level variances. Significant differences across the groups and over time are illustrated in Table 3. Differences between pre- and post-test scores for each country are omitted, since only one significant change was found: In the Italian sample there was a significant decrease (p<.05) in students means-ends-beliefs of luck. Figure 2 illustrates the raw score profiles across groups and over time.

		Task orientation			M-E-B of luck			Failure concern		
		NL	GR	I	NL	GR	I	NL	GR	I
Pre-test	B	*	*	*	ns.	*	*	ns.	ns.	ns.
	NL		ns.	*		*	*		ns.	ns.
	GR			*			ns.			ns.
Post-test	B	ns.	*	*	ns.	*	*	ns.	*	*
	NL		ns.	*		1ns.	*		ns.	ns.
	GR			*			*			ns.

Note. * p<.05

Table 3. Latent mean differences between groups and over time.

The results showed that the Italian sample had highest scores on task orientation at both measurement points and, together with the Greek group, lowest scores on means-ends beliefs of luck. In contrast, the Belgian group had lowest scores on task orientation, and together with the Dutch sample, the highest scores on means-ends beliefs of luck. Only one between-group difference was found in relation to failure concern: Belgian pupils' had significantly lower post-test scores than did both Italian and Greek groups.

[2]Following recent recommendations (see Browne & Cudeck, 1993), four indicators were used to examine model fit: χ^2-statistics (Jöreskog & Sörbom, 1989), Bentler's (1990) Comparative Fit Index (CFI); Bentler & Bonnett's (1980) Non-Normed Fit Index (NNFI); and Steiger's (1990) Root Mean Square Error of Approximation (RMSEA), respectively. In general, values close to .90 for CFI and NNFI, and values around .05 for RMSEA are considered good. Since the χ^2-statistic is found to be sensitive to a various factors, it was mainly used to assess comparative fit between different models.

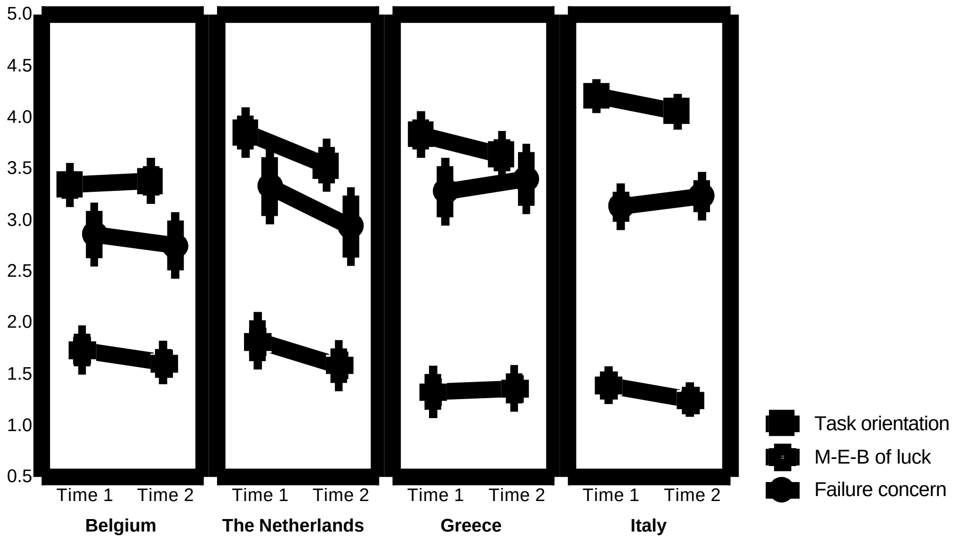


Figure 1. Raw score profiles for each country over time.

In line with the fact that the comparability assumptions could not be extended to include invariant variance-covariance matrixes (steps 4 to 6 in the preceding analyses), the examination of disattenuated correlations between latent factors showed that the relationships among these constructs were different across the groups (Table 4). Most accentuated difference from the 'general trend' was clearly the positive correlation between task orientation and failure concern found for the Italian sample at both measurement points. Although this unexpected relation seems to contradict theoretical considerations, it may be understood as reflecting the mutual interdependence of 'taking learning seriously' and simultaneously feeling pressure for it. It may also well be that the domains of 'performing' and 'learning' are partially confounded in these pupils' goal structure, and therefore the possibility of *not* achieving may be considered as an indication of *not* learning. This, in turn, would easily result in accompanying feelings of prospective anxiety. Nevertheless, more research should be done *within* each culture to better understand these puzzling differences in the relationships among pupils' learning-related beliefs.

	Belgium			The Netherlands			Greece			Italy		
	TO	MebL	FC	TO	MebL	FC	TO	MebL	FC	TO	MebL	FC
Task orientation	.57	-.15	-.09	.68	-.18	-.24	.69	-.22	-.24	.31	-.31	.17
M-E-B of luck	-.19	.41	.66	.16	.62	.34	-.33	.41	.12	-.18	.45	.04
Failure concern	-.35	.47	.68	-.05	.58	.79	-.10	-.03	.43	.26	.30	.49

Note. Raw score stability coefficients (between measurement correlations) in diagonal.

Table 4. Disattenuated correlations between latent factors.

Some minor differences were also found in the stability of each construct, but the overall level of stability was moderate across the samples. One clear exception from this pattern was the significantly lower stability in task orientation found for the Italian group.

However, at present, the data do not allow for more detailed evaluation of the possible reasons for this finding.

An important aspect to be considered when discussing possible sources or reasons for mean level differences concerns response styles - that is, tendencies of responding to questionnaires in certain ways. Some aspects of such bias can be revealed by examining the extent to which the members of each group use different response alternatives provided in the scale. The tendency to use extreme ends of the scales have been referred to as extreme response style, whereas the tendency to agree with statements is referred to as acquiescence (for examples, see Grimm & Church, 1999, Niemivirta, Rijavec, & Yamauchi, forthcoming). A straight-forward way to measure these tendencies is simply to calculate the number of times each respondent uses certain response alternatives. It is clear that such indexes are confounded with valid content variance, but they nevertheless appear to provide at least tentative information about response systematic. For the present purposes, simple indexes for extreme response style (i.e., response frequencies in categories 1 and 5), acquiescence (i.e., response frequencies in categories 4 and 5), and neutral responding (i.e., response frequencies in category 3) were calculated across all the items included in the final analyses. Group differences on these measures are illustrated in Figure 3.
Group comparison on these indexes revealed that Belgian pupils used the neutral response category more than others and showed the least acquiescence at the pre-test measurement. In contrast, the Italian participants displayed the most acquiescence and, together with Greek pupils, the most extreme response style. This was also true for the post-test measurement. Considering the fact that the scores of extreme responding and acquiescence were also rather stable over time (average correlation above .50), the differences found in mean levels might also - or in part - reflect genuine culture-bound differences in response styles. This also is a question that needs to be examined more thoroughly in future studies.

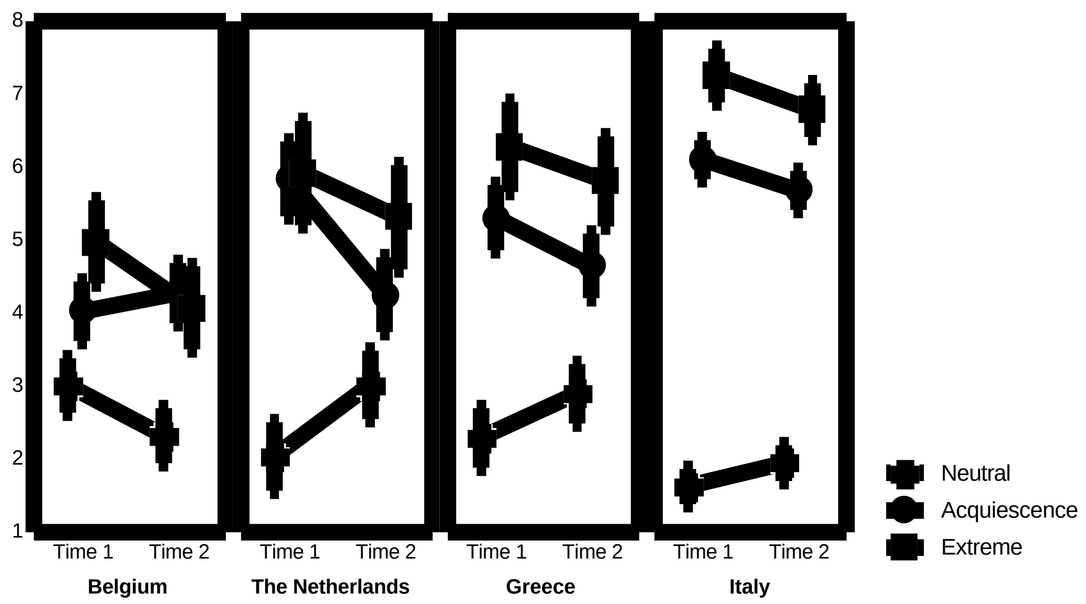


Figure 3. Group differences in response sets.

Few cautious conclusions can be drawn based on the analyses presented above. First, however, it must be emphasized that the scope of inquiry was rather limited. Only few samples and a very restricted set of items were included, thus leading to a rather narrow conceptual breadth. Nevertheless, some noteworthy results were found. The stability of measurements at the group-level was surprisingly high. Both construct mean levels and mutual differences between the samples remained rather similar over time. Despite some psychometric problems resulting from the administrative procedures, it still can be stated that at least some of constructs included in the present project seem to ‘exist’ and operate in similar ways across the participating countries. Further, a clear trend in mean differences was found that might reflect true cultural variations both in pupils’ motivational beliefs and in their response styles. In general, it seemed that the southern participants, i.e., Italian and Greek pupils, were more inclined to a bold and acquiescent response style that resulted in systematic group-level differences. Since these measurements were not related to any other measurements, it remains to be seen whether the within-group differences operate in a similar fashion in all samples. Also, for the same reason, nothing can be said about the potential significance of the group-level differences.

CONCLUSION

In the present analyses, all motivational data were utilized as reflecting project-related ‘outcomes’. However, as it was mentioned earlier, this approach may be slightly misleading. Even though the present results do provide information that help to analyse and interpret other data gathered in the project, a both conceptually and empirically more solid approach might be to treat motivation as a moderator (cf. the Finnish case study). In other words, the type of data collected - and the nature of motivational constructs the data reflect - might be more appropriately used from a person-centred perspective. That is, differentiating between different types of students, and then examining how the project and its constituents were experienced by them, and whether the ‘effects’ varied across the pupils. Yet, it cannot be emphasized enough that without the type of descriptive and comparative information obtained in the present analyses, the moderator perspective would be very difficult to realize. In this sense, these two approaches should not be considered as alternatives, but rather as complementary perspectives into the same phenomena.

3.6 COLLABORATION AND COMMUNICATION

Donatella Cesareni, Beatrice Ligorio

Introduction

One of the aims of the CL-Net project is to enhance collaboration and communication in order to promote knowledge building and (meta)cognitive skills.This goal can be attained both through communication inside the class (dyads and groups discussions) and communication at a distance supported by computers. In this deliverable different forms of collaboration are analyzed, considering data from field notes, teachers interviews, audio and video recording of students activities and a brief review of the communication occurred place over the Internet.

Collaboration between researchers

The first part of the project was especially focused on trying to establish a well functioning network between the researchers of each country involved. The collaboration among the five countries was based on previous collaborative projects in which the partners had already worked together (e.g. EARLI conferences, several scientific journals in the field, some common publications). Those previous experiences made possible a shared perception of the theoretical background for the implementation of the project.

During the project several communication tools have been used with different degrees of efficacy:

a mailing list: this has been the most used communication tool among the partners. Formal and informal information has been exchanged along all the phases of the project;

a web site: www.socsci.kun.nl/~clnet. It has been used mostly to share reports in progress. There are also included links to the mailing list and a "gallery" with all types of information about the partners;

Workmates (now available in its fourth version: www.kas.utu.fi/tporukka4). This is a groupware tool designed by the Finnish research group. This tool has been used during the first part of the project.

Beside the communication at the distance, the CL-Net participants attended to several meetings and conferences to share and discuss the progress of the project.

Collaboration between teachers and researchers

The CL-Net first puts a great stress on collaboration between teachers and between teachers and researchers. In at least two of the case studies, one of the aims of the research was to create a community between teachers and researchers (see Our world and Discover your town case studies). In those two projects a lot of effort was spent in order to let teacher communicate to each other. Several meetings were organized to give an opportunity to discuss problems and feelings and to found commonalties among the different schools partners involved. It was also implemented a forum for communication at a distance. In the majority of the other case studies collaboration between teachers was also an important point of the research. In fact: in The Netherlands the outlines of the different study projects were developed by the teachers in co-operation with the researchers, in Belgium teachers had several meetings with researchers and they experimented collaboration at a distance supported by a Knowledge Forum (KF) database. The KF database was intensively used and it consisted of three main parts: (a) a general background of information, (b) a discussion forum, (c) a

hotline for practical arrangements (see Leuven case study). In Finland teachers and researchers planned collaboratively the learning projects, in Greece, during the second experiment, weekly meetings between teachers and researchers took place, aimed at co-designing and discussing the experiment its-self.
In addition, one international meeting was held in Rome, with the participation of researchers and teachers of all the countries involved in the project.

Collaboration between students
In the great majority of the case studies, collaboration between students was enhanced not only through communication at a distance, but also in dyads, small groups, and class-groups interactions. Children worked in pairs at the computer, not for a lack of technological resources, but for a precise educational choice: stimulating children to discuss and interacting to each other, making explicit their thinking that sometimes generated productive cognitive conflicts. In the most of the experiments, dyads or small groups of pupils were considered as the unit of action and communication, also in the case of communication at a distance. It was also given some time for group activities (in Greece, in one of the Wageningen experiments, in Nijmegen, in the two Italian case studies) and for class-group discussions (Greece, Belgium, and Italy).

Evaluation of the collaboration
In their notes or interviews, teachers evaluated positively the collaborative learning experience for their classes. Teachers in Helsinki say that the use of the Computer Supported Intentional Learning Environment (CSILE) turned out to impact the interaction between students in CSILE database itself but also, for some extend, in the face-to-face activities. Also, the Italian teachers observed during the activity a clear improvement in children's relationship, in terms of being more open to listen to the others. Teachers in Nijmegen at the start of the project were unfamiliar with collaboration in classroom teaching, by the end of the project, the teachers felt stimulated to use other forms of collaboration, with or without the computer, in their teaching.
In the Belgium and Dutch case studies, students' interviews reveal interest on collaborative work even if for some pupils working with pairs remains problematic (see Belgium case study). Also in Greece, the students expressed during the interviews that they enjoined to work collaboratively.
The motivational and metacognitive questionnaires gave some information about the attitudes towards cooperation. Results are different in each country. In both the Italian case studies there was a significant increment in students positive perception of peer help and preference for collaboration. In Belgium, the metacognitive and the motivational questionnaires gave disappointing results. According to the results of the motivational questionnaire, the CL–Net environment seems to have a significant positive impacts on pupil's beliefs and attitudes toward cooperative learning, but these findings were not supported by that from the open "communication" questions of the metacognitive questionnaire: there was no evidence of any effect of the experimental setting. In Greece, there were gender differences in one of the components of the motivational questionnaire: the so-called "feeling that the other students help". The girls seem to have been particularly sensitive to the collaborative component of the experimental intervention, while no similar change has been detected for the boys.

Modalities of interaction and communication

Some countries had carried out deeper analysis of some of the dimensions involved in the project, such collaboration styles and cognitive and metacognitive effects of face-to-face and communication at a distance. For example, in the Greek case study a very interesting analysis of audio and video recorded makes possible to observe the type of collaboration that the students were experiencing as well as the cognitive, metacognitive, and motivational effects of their collaboration. Dyads styles of collaboration were classified in three categories: Reciprocity, Forced collaboration and No collaboration. When the interaction is categorized as Reciprocity style there is a great deal of planning, opinions' exchanging and task division among the students. In the No collaboration category the mutuality among students is completely missing. The Reciprocity style was the most frequent in the dyads interaction, with the 60% of occurrence.
Transcriptions of audio and video data were further analyzed and the text was divided into four different categories of exchanges: cognitive, metacognitive, motivational, and collaborative. About 50% of exchanges belongs to the collaboration category: students were mostly talking about issues related to aspects of their collaboration.
A very interesting result has been observed when combining different styles of collaboration with numbers of cognitive and metacognitive exchanges. Exchanges are related to the collaboration style: there are no cognitive or metacognitive exchanges in the No collaboration style, while the number of exchanges increase in the Forced collaboration and even more in the Reciprocity style.
The communication has been stressed also in both the Italian case-studies and the metacognitive questionnaire has shown that communication is influenced by the project in both samples. For this reason a further qualitative analysis of the communication has been done looking in particular to how communication is articulated and what are the specific features of the different type of communication.
Different phases of communication have been distinguished:

Communication in the classroom.
During this phase, although students are aware about the interlocutors at a distance, the communication in mainly based on ideas generated by the class its-self and it is very much influenced by the relationships between classmates.
This type of communication is aimed at producing or/and discussing information related to a specific issues coming either from the teacher, the researcher, or the students. Several situations can be included in this phase:
- class, group, or dyads discussion about information or idea generated by in-class activities,
- class, group, or dyads discussion about information or insight coming from out-side class activities,
- class, group, or dyads discussion about information coming from a software or a computer based activities where no external interlocutors are involved.
From the analysis on those types of communication is observed that contrapositions between discussants are not so uncommon and cognitive conflicts often take place (see "Our world case study").
With a specific reference to the communication generated by computer based activities, the "Discover your town" case-study shows that kids are able to co-construct knowledge, and to activate argumentative skills and critical inquiring.
Communication explicitly aimed to an external audience.
Not all the knowledge and the information produced and discussed in the class are shared with the interlocutors at a distance. Part of the communication in the class is aimed at re-organizing or selecting the information that will be posted or sent to the students located in other classes. A qualitative analysis of this phase leads us to conclude that this type of

discussion/communication needs to be organized by the teachers. What is worthy to be posted out? This is a questions that has to be raised through a good scaffolding, focused not only on the content of the information selected but also on organizational aspects, such as: alternation of individual and collaborative work, brainstorming, and reciprocal reviews.
When well scaffold, this phase can be very productive: previous ideas are developed and improved, new ideas are produced, and critical thinking appears.
Once the messages are posted on the Internet they seem to reach an higher status: they are published and hence, they are better. Pupils show to greatly appreciate their own work visible on a computer screen.

Communication at a distance supported by computers.
This phase includes e-mail messages and the discussion into the forum available. Analysis of this phase is focused on trying to define the interlocutor perception. Considerable changes are observed over time:
- initial messages are referred to a vague interlocutor, very often the interlocutor is not even mentioned. The messages are simply self-referred and suitable to any reader,
- later the content is more specific and it is observed a decentralization of the point of view. The message includes expectations, integration with information coming from others, references to other messages, and an internalization of the reader ("If I would read this I will like to understand...."). The topic of the messages became more specific along with a more specified interlocutor (see example of the communication about the first page for the common hypertext in the "Discover you town" case study).
In this phase children's' discourse is more based on interventions classified as "elaborated positive replies" and "problematisation" (see "Our world" case study).

Communication based on the external interlocutors contributions.
Consistent part the communication posted on the Internet or exchanged through e-mail goes back in the class and new type of communication phase takes place. This time the communication is based on the elaboration of the information coming from the partners out-side the class. Pupils in this phase show to be critical reviewers and to be able to distinguish between formal aspects and the content of the messages (see "Our world" case-study).
In this latter phase new knowledge and information is generated. In this sense this phase resembles to the first phase, with the difference that now a considerable part of the stimuli for the discussion comes from the interlocutors at the distance. The communication flow re-starts and slips into each of the phases described above. It is possible to see a circular and spiral flow where the communication goes back and forth from inside the classroom to across-classes. While the communication progresses to the next round of phases, the interlocutor at a distance gains a more clear identity and becomes more and more relevant.

CONCLUSIONS

Collaboration and communication are able to describe both activities taking place inside the class and across the classes. Those two dimensions are crucial for the understanding not only of the impact of the project but also of the cultural of a certain context. In fact, differences in terms of class culture and educational settings can be better detected when the focus in on the semiotic dimension, such as dialogue, reasoning, conversations, and discussions both face-to-face and computer supported. The analysis of the discourse and of the modalities of interaction between and within groups can be useful to compensate the problems occurred in the use of common instruments (motivational and metacognitive questionnaires) that inevitably are changed when translated and adapted by each site.

3.7 COLLABORATION IN CLASSROOMS VERSUS COLLABORATION BETWEEN CLASSROOMS

Henk Sligte

Introduction

This paragraph sketches a tentative comparison between the computer-supported collaborative work of pupils within one classroom and the collaboration of pupils in different classrooms. Among the latter are classrooms within one school, classrooms of schools within one region or country, and classrooms of schools in different countries. The comparison is based on the descriptions of the cases of Chapter 4, and the sections "Introduction in Schools: Addressing Challenges for Computer Supported Collaborative Learning" (Lipponen et al), and "Collaboration and Communication" (Cesareni & Ligorio).

Variations

In the CL-net project no statistical analyses were performed concerning the specific differences and resemblance's between the computer supported collaborative work of pupils within one classroom and the work of pupils who did not belong to the same form. The large variations in the different case-studies, all constituting complex multi-variable combinations of systems, actors and context-dependent factors, and the action-research oriented approach, prohibited these analyses. The project does provide various results of comparisons on the dimensions of cognition, metacognition, motivation, etc., as described in the other sections of this chapter, but not specifically on the theme of this section.

It is therefore that most of the results reported here are of a qualitative and indicative nature.

Distribution of the type of collaboration

Most of the collaborative work in the cases took place within the classrooms (in-class). In some cases this work was extended with collaboration with pupils of other schools (out-class), and only some international experiments have been done.

In Belgium four classrooms within one school participated in the project. The 85 pupils involved were grouped in fixed partnerships, consisting of pupils from the same form.

The pupils of all four forms were involved in a two-week international experiment with one form of 34 pupils of one of the Amsterdam schools.

In Helsinki, Finland, 21 primary schools pupils from the same form participated. In Oulo, Finland, 56 pupils of secondary school participated, of which 18 were studied in more depth. These pupils were of the same form.

In Greece five separate 6th grade classrooms with in total 130 pupils were involved. Although pupils did present outcomes of their projects to pupils from the other classrooms, there was no out-class collaboration.

In Italy (the Our world project) all pupils were involved in out-class collaboration as they were all linked together in the same forum space. In Rome 42 students of junior secondary education were involved and 46 pupils of elementary schools, while in Bari in total 24 pupils of primary schools participated. They used to work in collaboration inside the classrooms by discussing and building models, drawing maps etc. and then they put questions and problems in the forum area. In addition researchers and teachers from the Netherlands and Belgium posted messages in a forum within 'Il Nostro Mondo' but no actual international collaborations between pupils developed.

Yet another series of experiments took place around an interactive multimedia called "Discover your town" and a web site called "our castle". Six groups within both primary and lower secondary education in Rome and Bari participated. The total number of pupils added to 118. In addition 4 classes with 78 pupils acted as control groups. In these experiments a combination of in-class and out-class was chosen.

In Nijmegen, the Netherlands, six classes of the same secondary school, with in total 142 pupils participated. Collaborative learning evolved among pupils within the same class.
The Wageningen case study included eight classes within vocational education with a total number of 120 students, of which six classes with 76 students acted as experimental settings. The other 44 students in two classes were not involved in CSCL. The experimental groups involved are classes from both within class experiments and out of class experiments. Sites 1 through 4 (N=38) represent students who were not physically together (out-class experiments). Site 5 (N=38) represents students who participated while attending class (in-class experiments).
Three Amsterdam classrooms of three different primary schools with in total 64 pupils took part. Both in-class, out-class and international collaborations took place.

So in total about 1000 pupils and students from both primary, secondary and vocational education distributed over 9 towns/regions in 5 European countries were involved in the various case studies. Because of methodological problems, sketched elsewhere in this report, only a part of the collaborations were analysed in full.

In summary:

Country/Site	**In-class**	**Out-class**	**International**
Belgium	X		X
Finland - Helsinki	X		
Finland - Oulu	X		
Greece	X		
Italy - Roma (Mondo)	X	X	
Italy - Bari (Mondo)	X	X	
Italy - Roma (Town)	X	X	
Italy - Bari (Town)	X	X	
The Netherlands - Nijmegen	X		
The Netherlands - Wageningen	X	X	
The Netherlands - Amsterdam	X	X	X

Table 1: Differences between in-class and out-class collaborations

The first difference between in-class collaborative work and out-class collaborative work lies evidently in the fact that pupils either know each other physically or not. Also the teacher is known in the in-class collaboration. The environment in which collaborative work is done is the usual one. In the section on 'Introduction in Schools' it is stated that *"communicating with "faceless partners", is very different from the face-to-face communication. Especially the process of building common knowledge and grounding is very demanding through written language. Studies on learning interaction report difficulties in reaching common understandings even in face-to-face teaching-learning situations (Winne & Marx, 1982). As stated by Clark and Brennan (1991) grounding changes with the medium because techniques available in one medium may not be available in another. In written language explicating the* *referential relations of message creates context and grounding; in contrast these are usually known by participants or are easily checked in face-to-face communication."*

During in-class collaboration pupils have the disposition of their complete repertoire of interaction possibilities, including talking, making gestures, etc., while the teacher can act more flexible and offer 'just-in-time' scaffolds to guide the pupils. Of course the teacher has to have prior knowledge and skills for supporting the collaborations in order for mutual knowledge building to evolve. Often collaborative work is proposed for the sake of collaboration itself, and not for constructing knowledge. Results from the case studies indicate that the majority of the teachers involved did not dispose of a pedagogic-didactic repertoire for, or previous experiences with stimulating collaborative work. Previous experiences with CSCL are even scarcer. It is therefore that participation in the CL-net project proved to be educational for the teachers as well, as a form of 'on-the-job' professional development.

The culture of most of the schools and its classrooms does not offer ample possibilities for collaboration for knowledge building. Schools are still very much based on the traditional didactic triangle: matters of tuition are largely predefined in curriculum and the teachers' main job is to achieve correspondence between the more or less 'hard' knowledge and skills prescribed and the heads and hands of the individual pupil (see the Wageningen case study; Pea and Gomez (1992)). The schools' timetables often leave little time for experiments that diverge from the mainstream instruction. Participation in the CL-net project therefore also shed a light on new innovative ways of teaching and learning. To what degree these innovations can be sustainable, may be researched in a possible sequel to the CL-net project.

When using the computer for in-class communication and collaboration additional challenges are to be tackled. First the technology has to be put into place, and proper teacher education and guidance given. Then the pupils are to be introduced to the specific learning environment and allowed to practise. The former aspects are required for out-class CSCL as well.
Using the computer for communication in the classroom can introduce a certain sense of artificiality. In the Amsterdam in-class experiments the pupils felt constrained by the environment, and had the idea they could collaborate better without the new learning environment. In practice they just posted the solution of problems in the groupware, as the complete process of finding the solution together was done in face-to-face groups without the computer. The communication was mainly based on ideas generated by the class itself and it is very much influenced by the relationships between classmates, and the specific issues introduced by the teacher or the researcher. No information coming from outside the class influences the communication or collaboration.

In out-class experiments the environment for communication and collaboration is vital: without it these activities are simply not possible. Pupils are focussed on the environment for expressing their thoughts to others. These others are not previously known. It is therefore that the communication starts with introducing each other, while during the communication 'second order' interactions take place. These are the exchanges, not directly connected to the task but triggered by curiosity about the partners and their context. The motivation for using the environment for self-steered peer-to-peer interaction shows to be high.
Among this type of interaction is also the 'undesirable' language. The usage of telematic tools demand the emergence of human rituals as well. In some cases teachers had to intervene to prevent cursing or other strong language, while in other cases pupils had to offer their apologies.

The task-oriented out-class communication and collaboration is prepared in classroom (see the Chapter on Communication and Collaboration). Not all the knowledge and the information produced and discussed in the class are shared with the partners at a distance. Part of the communication in the class is aimed at re-organising or selecting the information that will be posted or sent to the students located in other classes. Once the messages are posted on the Internet they seem to reach a higher status: they are published and hence, they are better. Pupils showed to greatly appreciate their own work visible on a computer screen. Some observations indicate that using the computer can distract from the task as well: some pupils see the 'lessons' as computer-lessons, rather than focussed on a task.

The out-class collaboration needed to be organised by the teachers, both during the preparation in classroom and by offering additional scaffolds within the environment. Researchers or fellow-teachers provided the latter as well, sometimes in the form of tips and hints posted by a fantasy-figure (like Fixit or the Brain Crusher). The Wageningen case-study shows a connection between the role of the teacher in the database, the number of notes the students wrote and their reports about the amount and the quality of the collaboration. The less a teacher participated the less activity the students showed. This aspect may be subject of further research.

For out-class projects it is vital to make good appointments. Other than in-class collaboration, the teacher and the pupils are dependent on 'The Other'. The necessity of making good appointments is also known from other collaborative distance learning projects using common communication means like electronic mail. For example for 'teleprojects' within the European Schools Project the following tips are given with regard to matching pupils to collaborate with each other:

"For various reasons it is important that your partner and his/her pupils do not differ too much with regard to the following aspects:
Age: both forms should be of about the same age group;
Numbers: both forms should have about the same number of pupils;
Level: both forms should have about the same level of command of the English language.

Other differences between the two forms should not cause any problems. They might in fact make the link even more interesting."

Regular contact between teachers on the progress and a summative evaluation is important as well for out-class projects.

"It is vital to evaluate the project, both during and at the end, with your pupils and your colleague.
Every time that letters of the pupils are sent, you and your colleague abroad keep each other informed of the development of the project by adding an electronic note.
You can always send messages separately in which the development of activities or problems are reported. Also appointments that were made earlier, e.g. on dates of transmission, are discussed and changed if necessary. Plans with regard to the topics of the letters or the sequence in which they are dealt with may be adjusted. Sometimes the pairing of pupils is not successful. An example is the extremely diligent pupil co-operating with a partner who writes very concise letters. An end-evaluation is advisable. A suitable occasion is the yearly teacher conference of the European Schools Project. Of course this can be done electronically as well. Between pupils and teacher interim evaluations may prove to be worthwhile. Suggestions, questions, and ideas from the side of the pupils can improve the quality of the teleproject."

The most frustrating experience in these projects happens when suddenly the 'other' side is silent, and one does not know why.

"Electronic mail is a fantastic medium for communication. But you will have to keep in mind that e-mail needs some rules for successful usage, especially in education.
This is why Golden Rule Number 1 within the European Schools Project is **"ALWAYS ANSWER"**. Nothing is more serious than you not knowing what happened to your partner when there is complete silence or vice versa. So please take care that you always inform your partner, by e-mail, by fax, or by phone, about the reasons of hopefully temporary electronic silence."

In all, out-class collaborative work demands more support and preparation. And even then, ample possible break-downs are possible. In-class CSCL is easier to organise and support for teachers, but the extra value of using tools and ICT-rich learning environments for collaboration above 'normal' collaborative work, other than mere motivational, is to be demonstrated in a sustainable way.

Differences between synchronous and a-synchronous collaboration
Most of the computer-supported collaborative work in CL-net was done on a-synchronous basis. Postings in databases or forums were done while no one was instantly waiting for input. In this way partners in collaboration can quietly work on output for their collaborators, read and react to others' input. Teachers can spend time to support their pupils whenever necessary.
Specifically in the Amsterdam out-class experiments a synchronous mode was chosen. Although the sense of immediacy was enhanced, the idea of really collaborating at a certain moment, negative side effects were observed.
Groups of three pupils were formed, every pupil coming from a different school. As the lowest common multiple was 15 pupils, this number of groups was formed. In two of the schools pupils were thus excluded of the experiments.
The first problem was to find common hours in which the pupils could have joint sessions. Given the curricular and time pressure within each school, good appointments were to be made. Regularly sessions had to be postponed, however.
A second problem arose when pupils forgot to refresh their sessions. They just waited for contributions from the others, but without refreshing, other than synchronous chat sessions, nothing happens. Most of the irritations, leading to undesired language reported earlier, resulted from these events.
A third problem was due to the mere text-based communication available. Some of the less-competent pupils in writing or language in general, like in the case when the language used was not the mother tongue, produced shorter texts, thus unbalancing the conversation. A different role division when pupils communicate via the Internet with text sometimes appeared. In this kind of communication the pupils who can think and type fast have the leading role. These can be other pupils than the pupils with the leading role in face-to-face communication.

International collaborations
The main international experiment took place between the Flemish primary school and a class of one of the Amsterdam primary schools. Although effort was made to create a more extensive international experiment in autumn 1999 using the Our world-environment, various organisational and educational conditions prohibited its success. Among these conditions are

the foreign language problems, both with regard to texts to be exchanged and the Italian-language interface, the variety in the type of schools involved (from primary to vocational), and time problems. Flemish and Dutch teachers and researchers did contribute to the Italian forum in an earlier phase, introducing English language challenging statements that had been previously discussed in the mother tongue in one's own context. One of the statements was: 'Children within primary school should not wear hats and caps'. Although the statements triggered lively conversations among the Italian pupils, no actual Flemish-Dutch-Italian pupil conversations were the result. This was also due to the change of school year, after which pupils got other teachers, or even left school for secondary education.

The Flemish-Dutch experiment could be performed more easy, as:
- no foreign language problems would arise, which is essential for this age group;
- both sites had worked on similar content before: solving mathematical problems;
The Flemish teachers were enthusiastic about the collaboration with the Dutch teachers and they hoped the small exchange program could become the jumping board for a more intensive and varied contact with the Amsterdam school;
the Amsterdam researchers and teachers were very interested in what was being done in Leuven and they clearly indicated that they would like to be involved in the Leuven project;
all parties anticipated that the international project was more challenging and motivating for the pupils.

The 85 pupils of all four Flemish forms were involved in a two-week international experiment with one form of 34 pupils of one of the Amsterdam schools. This experiment can be seen as a more specific out-class experiment, to which the aforementioned dimensions apply.
In this project, the pupils and teachers first introduced themselves, the school, the city and the country to each other. After these introduction messages the assignment started. The pupils on every school were divided in 25 groups. Some pupils of the Amsterdam school were placed in two groups to get the number of needed groups. Every Flemish group was matched to one Dutch group. Each group designed one maths problem for the partner group in the other country. And each group tried to find a solution for the maths problem designed by the partner group in the other country.

The interactions emerging from the challenge to present problems for each other's partners were in total more extensive and dynamic. Although in all experiments pupils are supposed to be supported to collaborate with each other, sometimes the collaboration consists of mere communication, or even chatting, without the explicit invitation of replying or building on previous notes or messages. The concept of inviting to reply or expecting the processing of posed problems and the offering of solution strategies, and an eventual answer, leads to more sustainable communication and collaboration. With regard to the Flemish-Dutch international project more commitment to the interactions was observed, probably because of the fact that pupils felt 'ownership' for the problem they designed, and were curious how the other party would come to solutions they already figured out. In addition some language- and culture-related issues played a role here as well, although the Flemish and Dutch language are very similar. Dutch children for example liked it to read some 'funny' words written by their Flemish colleagues, thus increasing their commitment to the exchange between them. Also in other out-class experiments, notably in Italy, it was observed that some 'exotic' character of the distant partner increased motivation. The more distant, the more thrilling was the conclusion.

The concept of sustaining reciprocity is also used in pupil' materials for teleprojects using electronic mail. For example in the materials for the ESP-project 'The Image of the Other' building blocks and advice are given, like on the topic 'My school':

Content*: Don't forget to answer the questions your partner may have asked you, and to give your personal news. Start and finish your letter in the usual way. Use the answers as the bricks to build your letter.*

Build your letter*: You could start with: 'Thank you for your letter. I enjoyed reading it a lot. In this letter I'll tell you everything about my school.'*
Now use the answers to these questions write your letter:
How many pupils are there in your school?
How many subjects do you have?
What are your 3 favourite subjects? Explain why you like them.
Mention 3 subjects you do not like. Explain why you do not like them.
What do you like best about your school?
What do you not like about your school?
Tell something about your 3 favourite teachers.
Tell something about the other pupils at your school.
Mention 1 thing which has happened at school which you'll always remember.
(etc.)
You could finish with: 'I hope you have enjoyed reading this letter. I am looking forward to receiving your next letter."

Included in this 'lesson' are also the elements for building rituals for interaction. For example an extra hint is given:
"When you write about teachers, do not be too personal. It is good to have an opinion but it is not nice to "hurt" them. Remember they are only human too!!!"
International experiments, as a special case of general out-class projects, are to be prepared and supported even more meticulously. The variety is more extensive at different level. As sketched this variety can cause more commitment and motivation for communication and collaboration. But the sensitivity for breakdown is high, which is to be anticipated by the various actors involved.

CONCLUSIONS

As described in the chapter on Communication and Collaboration a good distinction is to be made between both modalities of interaction. Although computer-mediated communication is a prerequisite for computer-supported collaboration, the preconditions for stimulating the latter type of interactions with the aim to co-construct knowledge are more difficult to realise. As reported in the various case-studies communication is achieved in all test-sites, while collaboration for knowledge building was not realised in all cases. This is also due to the variety of contextual influences in the various countries and regions. Among them are the specific socio-economic, cultural and historical factors that have 'shaped' educational activities and systems to what they are

at present (see the concept 'learning patrimony' as researched in the TSER-project Delilah).

The in-class experiments can be seen as an extension of 'normal' lessons:

the environment is known to all actors;

everyone knows each other, causing less curiosity for each other's context or inclination to start 'second order' communication;

every actor has the disposition of one's normal repertoire, both for teaching and for learning.

When the computer is used for in-class communication some artificiality is sensed by the actors involved. Although the computer is a known seducer, its usage may distract from the task-oriented character of building knowledge together.

The out-class experiments are evidently more difficult to organise, but trigger more motivation. In various cases the pupils were highly motivated in receiving or sending messages to distant schools, with the impression that when the partners are more distant the more thrilling it was experienced. The teachers got more motivated in the use of the electonic communication because they saw their pupils to be enthusiastic about it. But to start a collaboration for knowledge building implies conditions that go far beyond motivation to communicate. A relevant condition is to having a reasonable scope that justifies collaboration at a distance and makes it more fruitful than collaboration within the class or the school. The teachers, in this case supported by the researchers, play a pivotal role in this process. Good preparation among the teachers involved, respecting and creating 'golden rules' for communication and collaboration, monitoring and participating actively in the computer-supported interactions, enhancing the teachers' competences both regarding their pedagogic-didactic repertoire in general, their ability to offer scaffolds for learning, and an orientation for innovation, belong to the conditions to be satisfied if computer-supported collaborative learning is to conquer a place in temporary European classrooms. Further research into these conditions will be necessary.

The international collaborative projects are a more specific elaboration of out-class computer-supported collaborative work and learning. As said, the motivation for active participation is likely to be higher, but the contextual conditions are more difficult to be satisfied. Language-and culture-related issues can pose insurmountable problems. One of the ways to overcome them is to define these problems as challenges for learning: differences in language can constitute learning goals as well in addition to task-oriented collaboration.

3.8 THE USE OF SCAFFOLDS –THINKING TYPES- IN SOME SITES

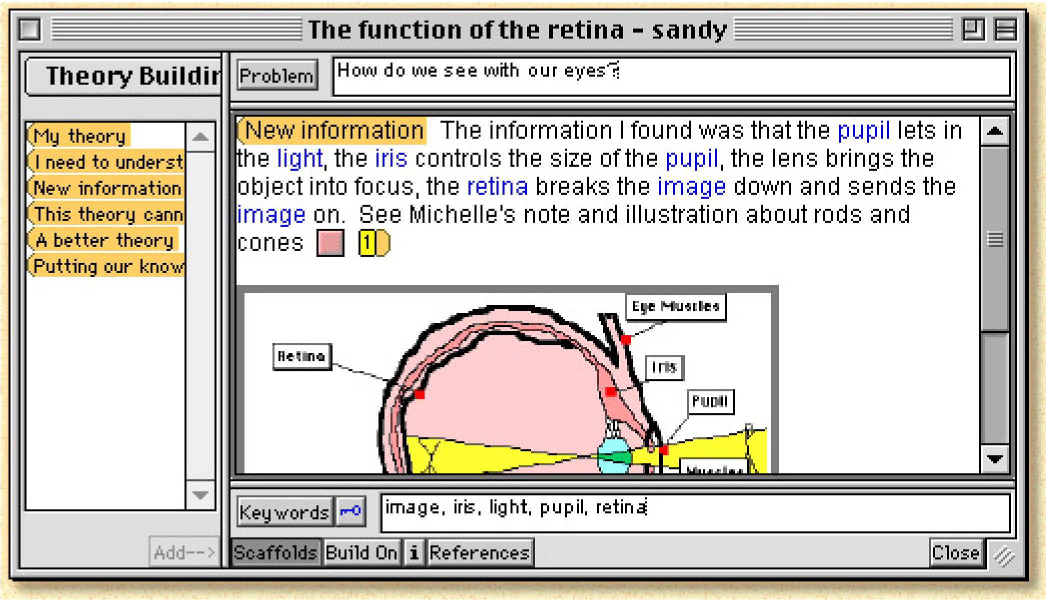
Gaby Lutgens, Frank de Jong

Introduction

In education it is still common to present knowledge from a rather traditional point of view. Pea and Gomez (1992) described this so-called transmission model as follows: an expert, for example a teacher, is the source of knowledge and this person provides the students with their knowledge. Transfer of knowledge only takes place when the teacher comes into operation. Consequently, the extent to which students gain insight depends on the quality of this transmission. The teacher’s transferrals of knowledge becomes crucial, whereas the role of the recipients of this knowledge is merely receptive. In the classroom it could be like this: the teacher explains something, eventually asks some questions to which the students can formulate answers, and, when possible, the teacher provides them with feedback. In this scenario the fact that understanding can be developed by an active and constructive learning process is neglected.

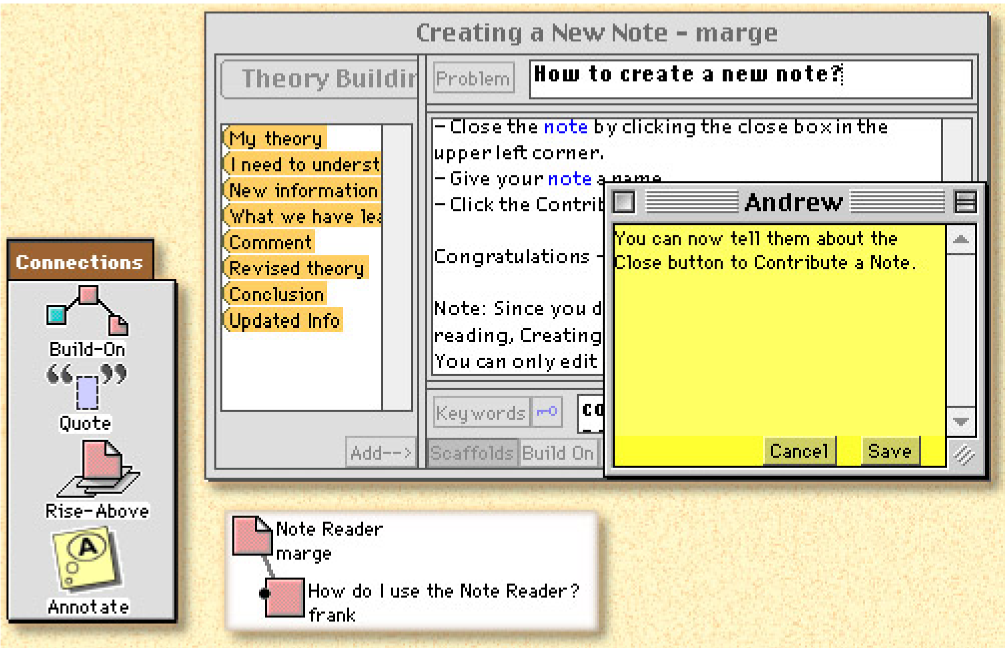
The learning in CLN’s knowledge building communities depends on ‘student-student’- and ‘student-teacher/or other’ interactions. These interactions has to be supported by knowledge building tools like student posed questions, defining their own goals, collaborating with peers as they acquire and build their knowledge database. So the collaborative learning is not just because there are more people but because of the embedding of the individual learning activities in community learning activities or the learning with others. To support this collaborative learning CLN-learning environments have to provide tools for collaborating, for progressive inquiry, to focus students on cognitive goals to build idea networks, to construct, store, and retrieve contributions, to referrer, quote, and track each others contributions, to identify knowledge gaps or advances, to view the knowledge theme worked on from multiple perspectives. A way to do this is to scaffold learners to direct them toward cognitive processes that will help their progress in learning and understanding. For instance, a theory scaffold takes users through the steps of building and verifying a theory. In addition, the process of identifying keywords helps users to focus on concepts they are discussing. But one of the first scaffolds if the way students can represent their ideas. In the 3rd generation of Knowledge Forum as developed by Scardamalia and Bereiter graphics to organize or express their ideas (see fig 1).

fig 1: Students’ representation of ideas scaffold by graphics to organize or represent ideas.



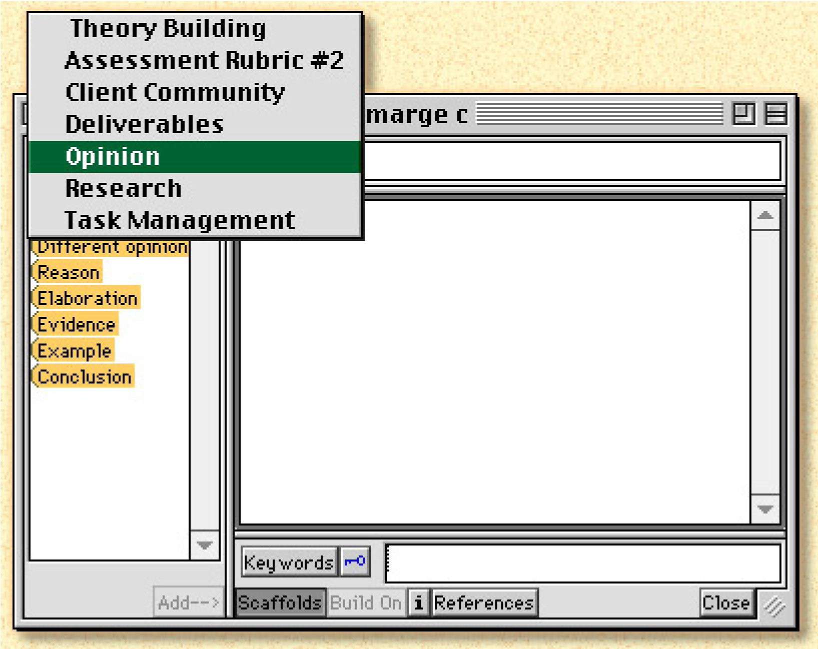
On these expressions students can build-on, make abstractions in rise-above-notes and make connections by quoting each other (See fig 2). They also can notated in contributions and share the authorship

Fig. 2 Different responding scaffold the interaction of the actors in a CLN-environment.



Learners and teachers in the CLN's can select different scaffolds (sometimes called thinking types) to support the presentation of their ideas and their processes such as reading difficult material, theory-building, and debate. These specially designed scaffolds support social and cognitive processes that further understanding. (see fig 3).

Fig. 3: Different scaffold/thinking types to support the formulation of ideas and the different cognitive and affective processes in the process of theory building, debate, research etc.



So if action is taken to change the role of the students in a way that they are more actively involved in gaining and building knowledge, it is important that they learn how to learn. They have to practice how to be responsible for their own learning (Scardamalia & Bereiter, 1994). When you want to make the students more responsible for the learning process, you should allow them to decide for themselves how to arrange their learning process. The students first have to become aware of how they actually learn. One way to do this is by asking the students to describe the action they are taking while learning. When they are involved in an electronically knowledge negotiation you can ask them to add a thinking type to the note they write to indicate the kind of contribution they are making. By doing this, the students become aware of the cognitive operations they are executing. The thinking types used in these experiments are based on the thinking types Hewitt (1996) used in his research on CSILE. Examples of thinking types used by Hewitt are *problem, I need to understand* or *plan*.

These thinking types show that typical contributions to WebCSILE are notes which include a question, a research plan or a summary of information found from resource materials. The notes are public and can be retrieved from the database and examined by any member of the class. Also in WebKnowledge Forum Students interact with each other by connecting their notes together with links and comments, by co-authoring notes, and by engaging in discussions.

Normally, one of the teacher's activities is directing how the student's learning process takes place. When the students become aware of how they are learning and what action they undertake to reach a certain learning goal (e.g. by using these scaffolds/thinking types), a shift in activities takes place from the teacher to the student; in other words scaffolding takes place.

By describing what they think, the students become more aware of how they solve problems and, consequently, they gain both cognitive and meta-cognitive knowledge. When knowledge-building starts to be the goal, the students will be capable of recognising what they need to learn. After some time they will take more active roles in learning and take more responsibility for the things they want to learn (Scardamalia & Bereiter, 1996, b).

WebCSILE supported the use of thinking types and offered the possibility to add or change them. This was done by the researcher before the experiment started and both the teacher and the students were made aware of these thinking types. During the experiment they were encouraged to keep on using them if usage dropped. In WebCSILE choosing a thinking type was part of the format. WebKnowledge Forum has not yet integrated this option and one way to add and use the thinking types is providing a list to the students and instructing them to put a thinking type (or more practically an abbreviation of the possible ones) in the title

When used consistently, it even is possible to select notes by thinking type. It appears to be necessary to remind the students regularly to use the thinking types.
Not all the participants in the CL-net project used the thinking types. The Finnish classes made use of WebCSILE and later on WebKnowledge Forum (WebKF). They used only the standard thinking types of WebCSILE (my theory, need to understand, problem, plan, new learning, no thinking type). They did not made use of thinking types after turning to WebKF. The Nijmegen partners used some abbreviations which could be put in the title (as described above). The others did not make use of thinking types to make the students aware of their learning process. Now a description follows of the procedure followed in Wageningen-site. Thinking types used in the pilot experiments:

- what I want to know
- problem
- my theory
- what I don’t understand yet
- plan
- something new
- no thinking type

It appeared to be that when one started to write a new note and did not actively choose a thinking type, *no thinking type* was selected. And writing a build-on note, automatically the same thinking type was selected as the new note-writer used. So, the selection of these thinking types was not always a really conscious one. This pleads for the use of title-encapsulated thinking types. So the titles function was used to add thinking type to support students and teachers to formulate their ideas and go through the process of learning and knowledge building. The explanation of the thinking type use was done by the researcher before the experiment started and both the teacher and the students were made aware of these thinking types. During the experiment they were encouraged to keep on using them if usage dropped. In WebCSILE choosing a thinking type was part of the format. So this not integrated option and one way to add and use the thinking types is providing a list to the students and instructing them to put a thinking type (or more practically an abbreviation of the possible ones) in the title. When used consistently, it even is possible to select notes by thinking type by using the thinking types abbreviations in the search machine. (see fig 4)

Thinking types offered in the current (WebKF)experiments:

- (MT) my theory
- (NI) something new
- (P) problem
- (Q) question
- (A) answer
- (TH) thanks! You helped me a lot
- (ID) I have an idea
- (E) explanation
- (RE) request for explanation
- (WK) what I want to know
- (WL) what I have learned
- (PL) plan
- (AG) I agree
- (DG) I disagree

The students had the opportunity to add more thinking types. The ones added are *assignment (AS, added by the teacher), announcement (AN), brainstorm (B), example (EX),* and *remark (R).*

Fig. 4: Notes and "build on'- notes in and thinking types use in the tittles in Web Knowledge

The sites in agricultural secondary education

In the Wageningen site eight classes with a total number of 120 students participated in the experiments. Six classes acted as experimental settings (N=76) and two as traditional settings (N=44) whose students study the same topic in a traditional (which means not computer supported) way. The experimental groups involved are classes from both within class experiments and out of class experiments. Sites 1 through 4 (N=38) represent students who are not physically together (out-class experiments); they collaborate only via webKF during the period they work in different firms. Site 5 (N=38) represents students who participated while attending class (in-class experiments).

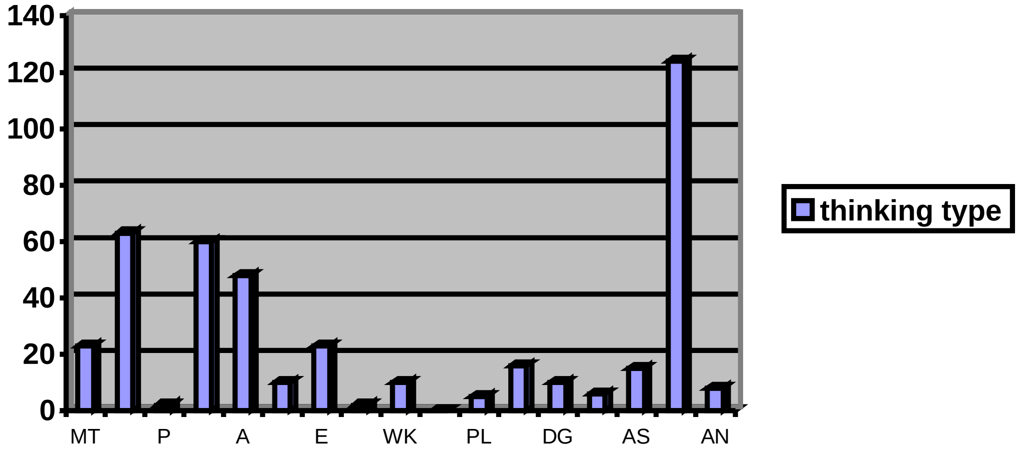
In table 1 an overview is given of the use of the thinking types in the Wageningen sites related to the category of contributions. Most scaffoldings are related to the start up of the databases and the elaboration of the task assignments

Categorized contributions	**number of notes**	**number of notes with thinking type (number by researcher)**
thinking types	60	53
Who is who introduction + start up	171	122
urgent questions]	45	33
chat	83	60
announcements	56	39
traineeship task assignments	155	90
My foreknowledge	3	2
TOTAL	573	399

Table 1: use of thinking types in the Wageningen sites

In fig 5 the use of the different thinking types/scaffolds are presented. The 'Remark'scaffold is used mostly. Also 'Need to understand', Questions and Answer are also used frequently scaffolds. Never used were the scaffolds What have I learned, Example and Brainstorming. Overall databases in 55 % of all the (444) created notes a thinking type was used..

Fig.5 The frequency of use of scaffoldings in the different sites

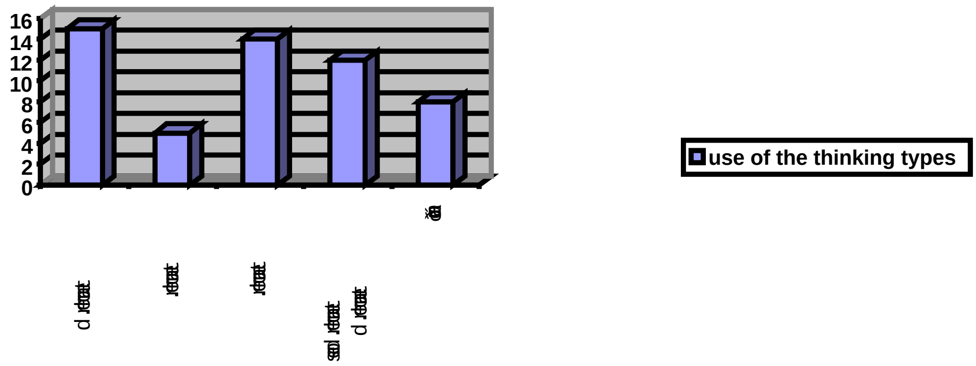


Students were evaluated on the use and significance of these thinking types. They were offered four questions:

- did you use the thinking types?
- what do you think is the purpose of these thinking types?
- would you want to add other thinking types?
- which ones?

Hardly anybody pointed out the lack of a thinking type combined with a suggestion (sometimes they already added thinking types during the experiment), but the first two questions provided interesting information. 69 % of the subjects mentioned to have used the thinking types, while looking in the databases it showed that in fact 96 % did (add a thinking type once or more times). Especially the ones adding them just once or twice stated they did not use them. Describing the purpose of the thinking types (an open-ended question) three main categories appeared: a. giving insight into the content of the notes you read (consumptive), b. making the message of your own contribution clear to others (productive), c. not useful, and d. providing extra information, e. is added like a rest category. Figure 6 gives an overview of the five categories.

Fig. 6 : students opinion about the use of scaffolding



CONCLUSION

Depending on the instruction concerning these thinking types and repeatedly encouraging the use during the experiment, students made use of the thinking types. From the above it can be derived that some groups made use of the thinking types to a much lesser extend than other groups. Students did think using them could be useful, but reading the by them attributed purpose of the thinking types they do not feel that using them helps them to structure their thoughts and ideas or give them more insight into their own learning process. On basis of these data you we could say that students are willing to use scaffolds or thinking types does however the functionality of it is not broad acknowledged. The Not useful category scores rather high although some students recognize the productive character and extra information character of using the thinking type.

One could say that the use of the thinking types has to be complementary and consistent in the way students are supported by the didactics in the non-electronic part of the CLN's . So the didactical methods used by the teacher in a normal Face-to-face-interaction has to be consistent. The strengthens and the functionality of the scaffolds could even be improved if they are consistent with the problems solving or knowledge building methods in the regular class interactions between student-student and student-teacher.

4. CONCLUSIONS AND POLICY IMPLICATIONS

4.1 CONCLUSIONS, RECOMMENDATIONS, AND IMPLEMENTATION

(Robert Jan Simons, Henny Van der Meijden, Stella. Vosniadou)

CONCLUSIONS

The program started on January 1 1998 and ended at the beginning of 2000. Apart from the partners, approximately 15 researchers were involved in the project.
Referring to the main goals of the project we can state that all objectives have been achieved:
Existing research on computer supported collaborative learning that aims to stimulate knowledge building (deliverable: Computer Supported Collaborative Learning, a Review, Lehtinen et al.) was synthesised.
Ways were found to introduce CSCL in schools. Didactical models, design principles and learning scenario's for the use of CL Networks in primary and secondary education were developed (deliverable: A Starters Kit for Teachers, Verschaffel et al.) and a description of software used in the project (Deliverable: description of software used in the CL-Net, Dhert et al.) Moreover we prepared teacher manuals, we interviewed teachers and students, we have been experimenting with variants of the software.
All countries experimented with different kinds of CLN-tools which support the learning process and the acquisition of knowledge building skills.
Cognitive, metacognitive, motivational and social effects of collaborative learning supported by computers were evaluated.
One cross-national experiment between schools in Belgium and The Netherlands was conducted.
Our results pertain to educational philosophy, didactics, technology and the introduction of CSCL in schools.

<u>Educational Philosophy</u>

It became clear that working with CSCL demands a certain educational philosophy from teachers and a certain new role from students. The educational philosophy focuses on knowledge building instead of knowledge reproduction as the main learning activity. This means believing in and trusting on active, self-regulated, constructive and contextualized learning by groups of students more or less independently. Both students and teachers are not everywhere used to this way of learning that is possible and needed when learning through CSCL. Moreover learning together with other students is also not an easy thing to do for many students and teachers.
It is not so easy to integrate this new educational philosophy with existing philosophies in schools.

<u>Didactics</u>

Our review of the research literature shows: that co-operative learning is effective if: students have common goals / interests combined with individual accountability. It also shows that it is very hard to realise co-operative learning in school practice. Descriptive research shows furthermore, that it hardly occurs in regular practice. The added value of computer support seems to relate to the following:

- easier organisation in classroom of collaborative learning;
- better visibility of collaboration processes (involvement of all students) in protocols;
- making communication patterns visible;
- structuring types of communication;
- making thinking visible: thinking types
- organising inquiry learning;
- learning to build knowledge and meaning collectively;
- building connections with practice; and
- opening new forms of collaboration (with other classrooms, schools, nations, and other partners like museums and universities).

Four types of explanation for the effectiveness of co-operative learning (under certain conditions) refer to motivation, cognitive development, social cohesion and negotiation of meaning and perspective co-ordination.
We noticed that both teachers and students like to work with CSCL very much. They saw the new possibilities and appreciated the new way of working. International exchanges between students of different countries can, so we expect to show, this motivational effect of CSCL.
It is not so easy to integrate new didactical practices in existing curricula. Teachers have no time and are not able to design the assignments and questions without extensive support for students that are optimal for CSCL. There are not enough didactical materials nor are there enough good examples available to help them fulfil their new roles.

Integration of CSCL in existing curricula and didactics is only possible if there is enough didactical support in the form of materials, assignments and counselling. International exchanges seem to have positive effects on motivation of students and teachers.

Technology

With respect to the question which software to use, several packages were compared systematically: CSILE: Computer Supported Intentional learning Environments, Webcsile, (WEB-)Knowledge Forum: (all designed by Bereiter and Scardamalia OISE Canada), Workmates: (Lehtinen, Finland), BSCW, First class server, Lotus Learning Space and E-web. Based on this comparison we decided to work with Knowledge Forum and Workmates.
Characteristics of all the software evaluated were:
- easy communication with groups of fellow students and teachers;
- flexibility and common workspace on a server; -
- making patterns of reactions visible (also graphically);
- aiming for knowledge building;
- empty workspace soliciting inquiry learning;
- working with thinking types.

Our data showed that both Knowledge Forum and Workmates are usable and feasible programs that can have great educational value. They can be introduced in schools quite easily, if the schools have enough computers available that are fast enough and that have Internet connections. Here there are, however, many obstacles: schools do not possess the computers needed. Knowledge Forum works the best with Macintosh computers, but these are not much present in the schools of Europe. Workmates demands a fast Internet connection this also not present in many schools. Many schools have only a limited number of

computers. Many have computers that are too slow. The number of Internet connections are problematical in many schools too.
The two programs used are relatively easy to use and learn. An important disadvantage, however, is the rather traditional interface with a heavy emphasis on textual information. This can be changed easily if we adopt another approach to software development. We need to integrate the programs in other available software in an object-oriented approach in which the CSCL software is easily connected with the other software and is not taking over existing functions of available software like text processors, drawing tools etc. This is especially true for the combination with content-related software (math, language, science, etc.). Because contents prove to be so important (se previous paragraph) integration of CSCL software with content related software is essential. We thus need much more flexibility. In order to make it possible to combine CSCL-software with other content-related and programs.
Availability of enough modern computers forms a major problem, blocking introduction of CSCL in schools. Further software development is needed to make it more flexible and less text-based.
The rapid development and expansion of computer network technology has had a strong influence on the tools and methods of CSCL. Networks facilitate students' collaboration also in situations where there are no opportunities for face to face communication. When learning interaction takes place through computer networks it opens new possibilities but also causes some problems that do not exist in face to face communication. In a network based environment students and teacher can interact through computer free of the limitations of time and place. Asynchronous and distance communication are new features of collaboration which challenge our pedagogical thinking. It makes more intensive collaboration possible with the out of school experts, brings students from different schools in contact with each other and creates powerful tools for joint writing and knowledge sharing.

Introduction in schools

In introducing the software in schools it became clear that we were introducing three innovations at the same time: the didactics of collaborative and co-operative learning; learning with computers and inquiry learning / knowledge building. Moreover, there were two curricula at the same time: the regular one and the one introduced by the program. Because the ways of learning are so different, students had problems with the transitions between the two. For teachers the introduction of the software in their classrooms amounted to the adoption of a new pedagogy. Their new roles caused fears of lacking control, lacking domain expertise and computer fears. It is therefore very important to establish a learning community of teachers and to provide adequate educational guidance for teachers. The challenge of introducing CSCL in schools is subject of a special part of this chapter.

Added value of technology

In the starters kit developed in the CL-Net project we wrote the following about the added value of Knowledge Forum and this is in our experience also true for the other kinds of software used in the project (Workmates, Discover your town, Our World, Future learning environments):
"What is the difference with face-to-face conversation? While face-to-face conversation is transitory, Knowledge Forum provides a permanent record of the community's interactions. This eliminates the need for turn-taking, allowing all students to work simultaneously.

Because the software is completely open and content-free, Knowledge Forum can be used – and has already been used – in, and at the intersection of, all areas of the curriculum. Moreover it can be used outside the school because students and the teacher can remote log in simply by typing the username and password on every computer linked to Knowledge Forum. Nor the teacher nor the school facilities are necessary for consulting and editing 'Notes'. This implies that Knowledge Forum is also well-suited for setting up interaction among partners that are physically (far) removed from each other. Working on an intranet in the school, students of one group, one classroom or one school, can build on the ideas or work on the problems of other pupils, classes or schools. Communication and interaction between groups of one class, between classes of one school or between different schools- national and international- are possible.
Generally speaking, Knowledge Forum is based on the philosophy that knowledge is a human construction that takes place as a socio-cultural activity, and that it is through apprenticeship with a mature scientist that young scientists' skills are acquired. As such, Knowledge Forum is intended to support the collaborative construction of knowledge in and beyond the classroom (Scardamalia & Bereiter, 1992, p. 41). Using Knowledge Forum involves changing the structure and culture of classrooms and patterning them after scientific research communities.
Knowledge Forum focuses on intentional learning. Intentional learning is defined by Bereiter and Scardamalia (1989, p. 363) as "cognitive processes that have learning as a goal rather than an incidental outcome". Essentially, it is a concern with student goals, and whether or not these goals are oriented toward personal knowledge growth. Intentional learners, by definition, are aware of their own cognitive development, and actively take steps to advance their own knowledge". Thus, using the interactive platforms used in the CLNET project facilitates new educational goals and possibilities related to new forms of communication (including distant communication), new ways of learning (collaborative knowledge construction) and new forms of intentional and self-directed learning.

The added value of computer support, using programs like Knowledge Forum, Workmates, Future Learning environments, Discover your Town, Our World as compared to face to face conversation, relates, in our view and experience, also to the following:
easier organisation in classroom;
Subgroup activities in classrooms are difficult to organise and create a lot of noise and uncertainty. CSCL helps the teacher to organise the process of between student learning in a quiet way.
better visibility of collaboration process (involvement of all students) in protocols;
Because the protocols of the collaboration between students are available to the teacher at all times he / she can have a better overview over the ongoing processes of collaboration, interaction and learning.

making communication patterns visible;
The software, especially in combination with the build-in analytical tools make it possible for the teacher to see the communication patterns: who is communicating with whom? Who is active , who is passive? Who is taking initiatives, who is reacting? What kind of input are different students bringing in? What is the quality and depth of the discourse going on?
structuring types of communication;
Through the use of Views that can be created and regrouped when needed, the types of communication as well as the contents of communication can be pre-structured en reorganized. Students can bring their own ideas, but teachers can also solicit the kinds of communication they find important.

making thinking visible: thinking types
Through the use of thinking types that can be changed and added according to the wishes of the teacher or researcher, the kinds of thinking students bring into the system can become visible to all actors involved.
organising inquiry learning;
Using the various kinds of software, processes of inquiry learning where the learner is looking for answers to self-imposed and other-imposed questions can be facilitated. Learners can work together in finding questions and answers, in this way learning in an active and motivated way.
learning to build knowledge and meaning collectively;
This inquiry learning helps learners to learning in a different way: they are building knowledge together instead of reproducing knowledge solitarily.
building connections with practice
Because of the internet connections of the software students can become connected to various kinds of outside real worlds. Learning can become related to real authentic problems of all kinds of representatives of society at large.
opening new forms of collaboration
Similarly, connections with other classrooms, schools, musea, companies and universities come within reach of each student. Although perhaps difficult to organise, these contacts seem to contribute quite well to student motivation.

Roles of institutions

The objectives of the CL-Net project envisage a deep change in the educational school intervention that cannot be viewed as a process restricted to the class teaching or learning environment but as a process which requires re-thinking at many levels of the school institution. Although in each country the case studies carried out by the CL-Net partners have engaged few school classes and have focused their attention and control on those classes, it is quite relevant for the dissemination of the results to highlight the reactions of the institutional context in terms of facilitation or resistance to the changes that the experimental setting introduced.
A systemic approach to the interpretation of the outcomes of any action undertaken in the school suggests to take into account not only teachers' decisions and actions on a micro level, not only to see them in relationships to their professional competence, or to the resources made available to them.

It is important to re-locate teachers within the network of relationships that includes the school community. Different levels, from the school institute organisation to the national educational system, have to be taken into account. The possible role of different institutions is subject of a special part of this chapter.

RECOMMENDATIONS

The CL-NET project involved five different countries, and a substantial number of schools, researchers and teachers in each country. Despite this diversity, there were a lot of similarities in the findings as well as in the problems encountered. For example, in all the projects the researchers and the teachers find that the students are enthusiastic with the new approach to learning that a CSCL introduces. They also find that there is an increase in the active and constructive involvement of most students in school tasks, accompanied by increases in the motivational, metacognitive, and cognitive measures used. There are also some common problems reported, and in this section of the report we will focus recommendations that will make it possible to deal with these problems in the future. The problems are of technical, and pedagogical nature and the recommendations will be discussed under these three headings. Furthermore, some recommendations are made for the possible role of other institutions.

Recommendations for dealing with technical problems

The level of the IT infrastructure is not yet sufficient, especially when the use of ICT is considered as pedagogically well based. Computers and computer networks will not be utilised optimally if appropriate learning materials are missing. Technology is getting more and more complex, maintenance must be transferred to experts in IT so that teachers can do what they supposed to do, namely provide pedagogical support (Sinko, Lehtinen, 1999). Technical problems include availability of hardware, network infrastructure and connections, access to information sources in the native language, and availability of appropriate software.

Availability of computers and network access.

Although a great deal of money have been spent to equip schools with computers, many schools, particularly elementary schools, do not yet have enough computers available for computer supported collaborative learning, or do not have the right kind of computers and the necessary network infrastructure. Even when computers are available in the schools, they are usually placed in one or two computer rooms and this creates a lot of problems because the computer rooms are not always available and easy to access.

It is becoming increasingly clear that in order for computers to be widely used in a school as a tool for facilitating learning in other subject-matter areas, they need to be distributed in the classrooms and several other computer activity areas. In addition, the computers must be placed in the classroom in ways that facilitate collaborative learning rather than traditional frontal teaching (Lipponen, Hakkarainen, and Rahikainen, this report). Similarly, network access must be possible from several places in the school and not only in certain restricted areas.

As Lipponen et al. mentioned in their chapter, there is great need to develop a new generation of school architecture designed from the beginning for computer-supported learning environments. School libraries should become more and more the centre of the school and should become (multi)mediatheques. In that case, the role of the librarians will change completely, from merely a person for checking in and out books, to a tutor and a guide in the search for information. Equipment should be placed so that students can work alone and in small groups (Dillemans, et al. 1998)

Software for computer-supported collaborative learning.

At this time there is still very few software available to support collaborative learning. In addition, the software that are currently available are often in the English language and are in need of further development. Most existing software for collaborative learning rely on written language and students use writing as the main form of exchanging information and learning through collaboration. Writing permits the externalisation of thoughts that makes it possible to engage in reflection and other metacognitive activities. Faceless communication is however difficult for many elementary school students, especially when writing is the main form of communication, making computer supported collaborative learning more appropriate for older students. Existing software need to be enriched with graphics, tables, figures, photographs, and other similar features (see chapters by Verschaffel, et al., and by Kraan et al.) to make them easier to use and more interesting particularly for younger students.

Technical support and teacher training in ICT skills.

There is no doubt that there is not enough technical support in the schools and that teachers are not well trained in ICT skills. More attention needs to be paid to these factors in order to build efficient computer supported collaborative learning environments in the schools. Teacher training must be increased, teachers at all levels need more technical know-how and expertise. Teachers also need to be trained in being a guide and tutor, and not merely the transmitter of information. Teachers should be supported in the creation of electronic communities. In that way they will develop new learning methods and form their own learning community.

Recommendations for dealing with pedagogical problems

Computer supported collaborative learning is very different from traditional transmission methods of teaching and requires the adoption of new roles for teachers and for students. From the traditional role of information transmitter the teacher must learn how to give more control and initiative to the students themselves to guide their own learning and to collaborate with other students.

Students on the other hand are usually enthusiastic about collaboration and about having control over their own learning but do not know how to use their time efficiently. They particularly need a great deal of guidance in order to engage in the knowledge building activities required for deep inquiry and for conceptual change, guidance that the teachers to do not usually know how to provide. An additional element that complicates matters is the nature of the curriculum itself. Information transmission curricula do not introduce conceptually challenging projects for students to do and do not allow enough time for activities with computers.

Teachers are concerned about teaching a great deal of factual knowledge in a limited period of time and are worried when computer supported collaborative learning takes up their time. Last but not least, teachers, school principals, and parents are often not persuaded that computer supported collaborative learning is indeed a better alternative than traditional transmission methods and thus do not try enough to make collaborative learning succeed.

Recommendations for the possible role of other institutions

Institutions present in the school territory, not only scientific institutions, are attracting the attention of the school and will increasingly participate in the educational community in the future. Opening the schools to activities beyond the school time might facilitate this encounter.

Integration between educational research and the policy of the national school institutions is necessary: experimental work should be a valued part of programs and plans to innovate the educational system. School administration, scientific institutions and school authorities should all be concretely involved in defining the needs of an ecologically valid experimental setting prospectively aimed at dissemination. Supporting teachers to disseminate the practices that they have acquired can make them feel ownership and pride about innovations they

contributed to promote. As long as this kind of collaboration not has been realised, even researchers will have hard times in justifying to their institutions the time and energy spent within the school to "construct" the artificial change that is the source of the data that they want to collect. Research questions risks to be disconnected from the actual school life, the outcomes of investigations scarcely affect the change of the system.
Teachers possess the key to the success of the use of computer technologies. Computers, software and pedagogical support must be provided as well as adequate training for teachers. Technology must be adaptable to the instructional needs of the teachers and to the daily realities of classroom life. Therefore the support from schools and institutions on different levels is indispensable.
The restructuring of educational practices is not an easy matter and the introduction of computers in classrooms for the last two decades has not brought about the desired educational reform. On the basis of the experience accumulated so far we propose the following recommendations.

- *Support action research on CSCL and facilitate its dissemination.*
- *Invest on teacher training for collaborative learning, knowledge building, and conceptual change.*
- *Study the processes thereby which self-guided deep inquiry takes place and understand how to guide it in the school environment*
- *Experiment with innovative curricula that introduce intellectually changeling topics appropriate for deep inquiry and conceptual change*
- *Provide the necessary institutional support for educational innovation. Educate school principals and other school authorities.*
- *Facilitate the creation of communities of learners, teachers and parents that are interested in CSCL.*

IMPLEMENTATION POLICY

What would be a wise implementation policy, given this state of affairs and these expected results? *In our view all of this means that an intermediate implementation policy should be chosen*. The focus in this policy should be on extension of the development of didactical materials in cooperation with the existing schools; extension to several hundreds of schools that can profit from the experiences in the pilot schools; further software development in cooperation with a large computer firm; development of didactical materials in cooperation with one or more publishers.

We advise the following actions:
Continuation of the pilot projects
In the 25 schools involved the number of subject matter areas and the number of hours spent per student should be broadened. In most schools the experiences thus far are still limited with respect to the number of subject matter areas and the number of hours of practice per student. Accomplishing effects of CSCL on metacognition, motivation, social skills and cognition, so we expect now, will demand a lot of practice and experience, more than has been the case in the schools in the current project. Therefore, we advise to organize a follow-up research project with the same schools, focusing on the long-term effects of CSCL in various subject

matter areas in which both the quantity and the length of experience is extended considerably.. Together with the teachers of these schools, didactical materials can be developed and studied for new disciplines. Furthermore the international dimension should be extended. In CL-Net project there was a small-scale international exchange. In a follow-up project, more of these exchanges should be organized, because the experiences so far promise interesting and important effects of the international dimension. Also the European dimension should, in our view, be extended.
There is a need for theoretically well grounded development of CSCL practices and tools which are adequately embedded in practical educational context. The results of previous research also highlight the importance of carefully analysing the presuppositions of application of technology-based instructional innovations in practical classroom situations. Especially following questions have been raised in our previous research:

- whether school children, collaborating within a computer-supported classroom, could learn a process of inquiry that represented certain principal features of scientific inquiry (Hakkarainen, 1998)?
- how similar is the subjective learning environment experienced by the students to the beliefs of the researchers (see Järvelä, Lehtinen & Salonen, 1998)?
- are the innovative environments beneficial to all students or are there subgroups suffering from the new methods due to their motivational and social orientation (Järvelä, 1996; Salonen, Lehtinen & Olkinuora, 1998)?
- are the technological skills and pedagogical beliefs of teachers appropriate in relation to the requirements of the new learning environment (see Hakkarainen et al., 1998)?
- are there national or local cultural practices and beliefs conflicting with the intended teaching learning methods (see Hakkarainen et al., 1996; Lehtinen et al. 1997)?
- what are the ‘scaling up’ effects: is it possible to provide similar opportunities for all students as there are available for a small amount of students in advanced experiments.?

Introduction of CSCL in another 100 / 250 schools in the five countries involved.
These schools can profit from the experiences of the first 25 schools. Each school will collaborate with 4 other schools in order to learn from the experiences of the pilot schools. In these schools the teacher manuals and the didactical materials developed in CL-Net should be used in order to facilitate the introduction in these new schools. In these schools teacher communities of practice will be organized, where teachers use the same software as the students. They will learn from each other as well as from the experiences from the teachers in the pilot schools. Research in these schools should focus on the implementation processes (learning communities) and not so much on the development of materials as in the 25 pilot schools.

Software development

In co-operation with a computer company the software should be refined and improved. Current developments of Workmates 5, our own European software, focus on the flexibility and the user-interface. CSCL is now an object that can easily be integrated in all kinds of other programs, making the applications much more easy and user-friendly. The new Workmates 5 program can also be combined with Knowledge Forum, so that the strengths of both programs can be combined. This program development should be done with a large international computer firm and should be made extremely flexible in order to prevent dependency on computer specialists. Moreover, the program should get a user-interface that is aligned with current habits and is attractive for young students. This means integration of audio-visual, graphical and virtual realities.

Development of didactical materials in co-operation with publishers

Because integration in existing curricula and relations with content materials form major problems in introducing CSCL in schools, the further development of materials and manuals should be done in co-operation with a publisher who can take care of integration in existing curricula. In each country, one or more publishers should become involved in the cooperation network. When we started CL-Net, we believed that content-independent approaches would be feasible. Now we know, however, that this was too naive. Teachers do not have the time nor the possibility to develop the materials and assignments that are needed.

4. 2 INTRODUCTION IN SCHOOLS: ADDRESSING CHALLENGES FOR COMPUTER SUPPORTED COLLABORATIVE LEARNING

Lasse Lipponen, Kai Hakkarainen, Marjaana Rahikainen

Introduction

Computer supported collaborative learning (CSCL), especially, offers promising innovations and tools for restructuring teaching-learning processes to prepare students for the future (Koschman, 1996). Recent research literature reports positive effects and potentials of CSCL: enhanced individual learning outcomes, and higher group performance, especially with regard to knowledge construction (for a review of CSCL see Lehtinen, Hakkarainen, Lipponen, Rahikainen, & Muukkonen, 1999).

Despite positive results and visions of computer supported collaborative learning, we should also take into consideration the challenges of collaboration. Collaboration, with or without computers, is not always favorable and teams do not always function as best they can (Hakkarainen, Järvelä, Lipponen, & Lehtinen, 1998; Lehtinen, Hakkarainen , Järvelä, Lipponen, & Ilomäki, 1997; Salomon, 1997; Salomon & Globerson, 1987). The general passivity and uneven distribution of participation, superficial and shallow communication, divergence of ideas, new challenges of motivation, the lack of explicated scaffolding practices, and the difficulty of using writing as the main medium of collaboration appear to be common but seldom analyzed problems in computer supported collaborative learning (Edelson, Gordin & Pea, 1999; Eraut, 1995; Guzdial, Realff, Ludovice, Morley, Clayton, Lyons, & Sukel, 1999; Hakkarainen, Lipponen, Järvelä & Niemivirta, 1999; Lipponen, 1999; Stahl, 1999).

PURPOSE

The purpose of the article is to review empirical case studies (see appendix A & B) conducted in Finnish elementary school and based on the review analysis point out technical, organizational and pedagogical challenges of working on CSCL. We begin by giving a short description of the case studies reviewed. After this a discussion of challenges of working on CSCL is given. In each section a little theoretical introduction is presented followed by our empirical findings. Each section is closed by a short discussion. We close the article with general conclusions.

Description of the case studies reviewed

Settings

The case studies reviewed are part of a larger project (EC project nr. 2019 Computer-supported Collaborative Learning Networks in Primary and Secondary Education) that aims to develop and implement pedagogical practices and models of CSCL, and to analyze the cognitive, social and motivational effects of CSCL in Finnish schools from elementary to university level. An important part of the overall research project is to carry out intervention studies of CSCL in normal school environments and analyze data from naturalistic contexts (Järvelä, Hakkarainen, Lehtinen & Lipponen, in press).

The case studies were conducted in two elementary classes (9-12- year-old students) in the city of Helsinki during years 1995-1998. The classes participating in the study worked with CSILE (Computer Supported Intentional Learning Environments, sSee Scardamalia, Bereiter, McLean, Swallow & Woodruff, 1989) in their study projects. CSILE is a network learning environment for fostering higher-level processes of inquiry in elementary education. CSILE provides a forum for engaging students in a process of generating their own research questions, setting up and improving their intuitive theories, searching scientific information, and sharing their cognitive achievements. A central part of the system is a communal database for producing, searching, classifying, and linking knowledge. Students use CSILE by writing notes, creating charts, and reading and commenting on each other's productions.

In the present case studies CSILE was used to facilitate a research-like process of collaborative inquiry in which generation of the students' own research questions, intuitive theories and search for explanatory scientific knowledge played an important role. During the years 1995-1998 students and teachers performed several projects focused on topics on biology, physics, environmental studies, and geography and produced, in all, almost 4000 CSILE notes. In study projects students worked in pairs or in small groups for different subprojects under the main topic. The lessons consisted of classroom discussions with the teacher, working with different resource materials (books, Internet), making empirical experiments, and working with CSILE. To foster collaboration students were encouraged to write their research questions, explanations and comments to CSILE for a collective good.

Participants

Both classes (A and B) conducted approximately four CSILE projects during the school year and an intensive CSILE project lasted 4 to 6 weeks. The first year (95-96) was an exception; during that year, class A performed several projects simultaneously. The teachers initiated the projects, and there was only a minimal amount of direct intervention from the researchers.The class A was taught by the teacher A, who had 7 years' teaching expertise in handicraft. However, the beginning of the project in 1995 was his first year as an elementary teacher. Thus his pedagogical experience was mainly gained through CSILE projects. He was an expert in educational technology and all the time developing his expertise in this field. Presumably, he was more interested in educational technology itself than pedagogical issues. In 1996 he met members of the Canadian CSILE team and was in loose contact with them during year 1997. The class B was taught by a teacher B with four years of experience as an elementary teacher. In 1997-1998 she participated in a 15 study weeks' (credit units) special in science teaching. However, she did not otherwise have no intensive experience in science teaching.. In the beginning of the project the teachers were not familiar with cognitive ideas of technology supported inquiry learning and did not fully notice the cognitive value of collaboration.

Two things are characteristic to Finnish teacher profession in elementary level. Firstly, teachers in elementary level are very rarely subject matter experts and do not necessarily have expertise in science teaching. Instead they teach many subject matters such as biology, mathematics, environmental science, and reading and writing. Secondly, in Finland, the same elementary teacher works with the same students for four years following the class from one grade to another. In the present case, teacher A worked with the same students during years 95-98.

In class A the number of students changed little over the four years; two students left and one new student joined the class. In class B three students left the class in spring 98.

Further, in both classes were approximately four to five students with experienced problems in academic aspects of schooling. They had problems in reading and writing and some of them had also personal problems and problems in family-related issues that might have affected to they academic work in school.

Data-Collection

In classrooms several factors and processes occur in relation to the other factors and processes (Salomon, 1996). For that reason, a multi-method approach was used in the data collection of the case studies: students' written productions from the CSILE database, teacher and student interviews, students responded to a self-report questionnaire of motivational orientation, videotapings of students' learning processes.

Data analysis
The following methods were used to analyze the data: Qualitative content analysis (Chi, 1997; Hakkarainen, 1998; Krippendorff, 1980) was used for analysing students' discourse practices and teachers' scaffolding mediated by CSILE and also for analysing interviews. Social network analysis was applied for analysing discourse practices and participation in CSILE work, and on-line motivational analyses for analysing students' motivational orientation during CSILE work.

Challenges of working on computer supported collaborative learning

The review of our intensive case studies showed that in order to successfully use CSCL in natural settings several challenges have to be met, challenges which can be divided into at least three categories: technical, organizational, and pedagogical. The challenges are given in detail in the following sections.

Addressing technical and organizational challenges
By "technical challenges" we mean teachers and students' expertise in ICT (information and communication technology) and access to ICT. "Organizational challenges" refers to the issue of how to obtain whole-school organization support for educational change with CSCL.Technical solutions, such as how computers are located at school, have significant pedagogical implications. An equally important factor is how many and what kind of computers and what kind of network infrastructure and network connections are available at a school. These solutions determine the nature of kind of access the students have to Information and communication technology.
There are two basic models of placing computers at school. The first, currently predominant, solution is to place computers in one or two computer rooms (the centralized model). A problem that emerges from the centralized model is that teachers who are responsible of computer room and who are, frequently, also teaching ICT skills as such, have control over the computers. In many cases, the other teachers do to get access to the computers at all because the ICT teachers take over. Another model is to create several activity centers all over the school in which students can work with computers (the distributed model). The latter model presupposes that there is a larger number of computers than in the first case. Frequently, schools relying on the distributed model have also separate computer rooms; the models are not mutually exclusive.

Another important consideration is how computers are arranged within a computer room; are they arranged in a way that supports teamwork or more traditional frontal teaching. The underlying educational philosophies are usually totally different; the centralized model facilitates teaching ICT skills as such whereas the distributed model elicits the use of ICT as a tool for studying different domains of knowledge. It seems that in order to make computer use a regular part of normal activity of schools, the computers should be distributed over a school both to its classrooms and in several computer activity centers.In the case of our Finnish CSILE experiments, the teacher A had seven computers in his own classroom for working with CSILE. However, teacher B had to take her students to a computer room located in another floor in order to use CSILE. In the computer room there were not, however, enough computers so that all students can work with computers simultaneously, even in pairs. As a consequence, the teacher had to split the classroom. The problem was that she was not able to be at two places simultaneously, and she found herself running up and down stairs trying to get both of the groups to work effectively.

In order to practice intensive CSCL, teachers need to have a number of computers in classrooms they are teaching. In many cases, however, there is not enough space for computers in regular classrooms without substantial changes in architectural characteristic of the classroom and school as well as changes in the pieces of furniture used. These problems have led to the emergence of new generation of school architecture that is from the very beginning designed to support collaborative learning supported by ICT. Accordingly, these schools have network access everywhere at school, not just a few plugs here and there (placement of the plugs frequently constrain possibilities of rearranging computers). Instead of having traditional closed classrooms, these schools are designed to provide open spaces for carrying out schoolwork.It is possible that teachers' limited knowledge and experience of information technology also constrain the possibilities of practicing computer-supported collaborative learning. The results of a study conducted in Finland by Hakkarainen and others (Hakkarainen, Muukkonen, Lipponen, Ilomäki, Rahikainen, & Lehtinen, 1999) showed that only a small percentage of elementary and high school teachers had adequate skills of information technology although a majority of them had access to computers either in their home or at school. In addition, ICT was used most intensively by teachers who are relative experts in ICT and, presumably, very interested in information technology as such. It follows that it is very important to provide teachers with adequate skills of ICT as well as sufficient technical support.

If we admit that curriculum very strongly guides what teachers and students are doing in the classrooms then we might ask, what is the role of technology or collaborative work in the curriculum. How much space and time is given for students to do computer supported collaborative learning and how is this organized? It is likely that active participation in CSCL requires substantial changes in traditional curriculum.

However, phenomenon we call "The problem of two curricula" appears to be very common in classes that are implementing or using new technology. The two curricula seem to co-exist side by side, often unnoticed. The first curriculum followed in our classrooms was the traditional information-transmission curriculum focused on making sure that each student "carried out the assigned tasks". The teacher assumed responsibility for the higher-level cognitive activities such as generating questions and explaining and took charge of metacognitive activities like planning, monitoring and evaluating. In the second curriculum, which we call "collaborative inquiry with computer networking and support", students were encouraged to take more responsibility for their own and their fellow students' learning. If these two curricula are not integrated or supportive of each other, it is very difficult to achieve the pedagogical goals of either of them or to bring about the second-order effects of educational technology.

Addressing pedagogical challenges

Teacher-student-interaction. In computer supported collaborative learning, the traditional role of the teacher as information deliverer is changed to a role of facilitator and co-learner. This means facilitating collaboration between students, encouraging them to monitor their understanding (without directly giving them information), communicating with them and carefully examining knowledge produced by the students. The last two appear to be extremely important in the case of networked learning environments such as CSILE. The teachers of the Finnish CSILE classrooms did not participate very actively in the students' process of computer supported collaborative learning. This was evidenced especially in their contributions to the students' CSILE mediated discourse. During the projects, they provided only a few comments on students' notes and did not systematically contribute on the students' collaborative learning process or comment on the students' knowledge productions. They provided certain preliminary questions for the students to answer, but did not systematically contribute of the students' knowledge-building process or comment on the students' productions. Students were left to carry out some kind of unguided discovery learning (Hakkarainen, Lipponen & Järvelä, in press; Lipponen & Hakkarainen, 1997). In interviews, they told investigators that they do not have enough time to do CSILE work because the normal schoolwork takes most of their time. In order to successfully elicit higher-level practices of collaboration, the teacher should not let the students alone, but provide an expert model by example. Generally, we cannot expect that students in conventional classrooms will discover high-level practices of collaborative inquiry and carry out productive knowledge building processes.

However, there was one exception: In one project, Energy, Teacher B was very active. While students produced 127 CSILE notes during the project, she contributed to the discourse by producing 30 notes of substantial he pedagogical and cognitive value. Her comments were supportive; she requested students to do some more research; she did not produce direct answers nor direct guidance, but instead the objects of her comments were students' intuitive conceptions, as she tried to guide them in monitoring the progress of their understanding. (Example comments: What do you mean when you write that energy is power? Could you explicate this issue? Good note. But is energy really matter? If it is, what kind of matter do you mean?).

Yet her comments did not appear to have any effect on students' work for students did not respond to her comments (Lipponen, Hakkarainen, Muukkonen, & Rahikainen, 1999). Several reasons might explain this phenomenon. First, there might have existed a substantial knowledge management problem. A large number of messages in the CSILE database can make difficult to follow the discussion and get on overview about issues being discussed. An intensive discussion - possibly ten or more steps deep - is time and effort consuming to follow (Muukkonen, Hakkarainen & Lakkala, 1999). Further, students might not have fully understood the idea of sharing knowledge through networked learning environments and perhaps did not understand how the technology can support collaboration.

Learning projects. Quite common to Finnish CSILE students was to carry out conceptually unchallenging CSCL projects. It seems that the design the projects carried out guided the students in working with factual knowledge rather than searching for explanatory scientific concepts and information. The projects focused mostly on observable empirical phenomena such as selecting an interesting phenomenon (e.g., species, countries, and places) and searching for basic information about it. As a consequence the nature of knowledge produced by the students was empirical (i.e., not conceptually organized) across all students. This seemed to reflect the nature of the learning tasks carried out rather than individual cognitive achievements. It would have required considerable mental effort from students in the Finnish groups to transform the given learning tasks into more challenging ones and to go deeper into the topic when the learning tasks in question did not require in-depth conceptual understanding. The nature of knowledge produced was empirical (i.e., not conceptually

organized) across all students, and this seemed to reflect the nature of the learning tasks carried out rather than individual cognitive achievements.
It appears that elementary school students do not break the constraints of concurrent pedagogical practices or the boundaries of empiricist epistemology without the teachers' cognitive and epistemological guidance (Lipponen & Hakkarainen). Without a teacher's direction or examples of advanced models of cognitive practices, all students, regardless of their individual cognitive competencies, might well remain at a more elementary level in their inquiry.
Further, it was common to the Finnish classes that the students' own intuitive theories were not systematically facilitated. They were not encouraged to construct their own hypotheses, conjectures or theories. Engaging students in a genuine process of collaborative inquiry is a very challenging task, requiring much effort from teachers. It requires building a new culture of learning where students' generation of their own theories has a legitimate role. A necessary prerequisite for emergence of constructive, scientific-style of inquiry appears to be a culture in which each student is encouraged to articulate his or her intuitive theories, and in which each theory is respected as well as critically evaluated. This kind of culture allows each student to participate in articulating of explanations without being afraid of unavoidable mistakes.

Subject-domain expertise. A challenge, at least in Finland is that elementary school teachers are seldom subject-domain experts. As a consequence, they are not very eager to carry out conceptually challenging collaborative study projects but rather wish to focus on issues connected with the students' concrete and familiar environment. The problem of teachers' domain expertise is even more serious in conceptually challenging science domains such as physics or biology. In fact, the Viking topic was a compromise constructed because science topics were completely rejected.

Teacher community. Several development projects have shown, that it is difficult for even very experienced teachers to adopt and apply new advanced pedagogical methods (Lamon, Reeve & Caswell, 1999). To be able to work effectively with CSCL and to follow modern cognitive ideas many teachers must achieve a substantial shift in their pedagogical and epistemological practices.
Originally we worked with just one CSILE teacher from a school. However, it soon turned out to be more productive to engage many teachers or the whole community of teachers with or without computers to rethink and reconsider about their current pedagogical practices and search for new pedagogical practices as well support each other. It might be easier for a group to make a commitment to change, as compared seeking commitments from isolated individuals.

Instead of getting an individual teacher to become involved with CSCL, perhaps one should try to involve whole teachers' pedagogical community. It may well be easier for a group of teachers, some of whom are proficient with technology, to successfully facilitate CSCL. A very critical aspect of facilitating pedagogically meaningful use of ICT and practices of CSCL is training of teachers. Just bringing computers into the classroom does not automatically lead to desirable pedagogical changes (see Hakkarainen & Lipponen, 1998).
Student-student-interaction. Several concurent research projects stress the importance of student-student-discourse in learning and knowledge building (Brown & Campione, 1996; Chi & VanLehn, 1991; Hakkarainen, 1998; Scardamalia & Bereiter, 1994). Computer supported learning environments offers a new medium for a classroom discourse that might facilitate and organize peer interaction and offer participants possibilities to pursue

pedagogically valuable discourse. How are these possibilities realized?Our analysis of students' CSILE mediated communication revealed three pedagogically and cognitively different modes of discourse: social-oriented, fact-oriented, and explanation-oriented discourse (see also Lipponen, 2000). These practices of discourse differed essentially from each other in the nature of knowledge students constructed during discourse and in object and focus of students' communication.

Characteristic to social-oriented discourse was that the goal of communication was not related to the topic of students' inquiry or to the formal content of subject matter. At this level the CSILE was used only for purposes of social correspondence and exchange, such as utterances of social conflict ("who are you to tell me what I am allowed to do") or greetings ("how are you doing"). Characteristic of this kind of correspondence was that interaction through the CSILE was not intentionally focused on learning. "Positive social talk", however, might serve some important functions, such as creating group cohesion, increasing motivation and activating participation in discourse. Social-oriented discourse represented more a person-to-person communication than from one-to-many communication.

Discourse was considered factual in nature when students presented factual statements or fact-seeking research questions (what, who, how many) that were commented by another students with factual comments or with factual answers (a list of facts expressed, no causality and inference expressed). Fact-oriented discourse was also the most common pattern of communication between the CSILE students (Hakkarainen & Lipponen, 1998; Lipponen & Hakkarainen, 1997; Lipponen, 2000).

This type of exchange pattern of communication led to episodes that were usually very short, containing only few contributions. As a consequence, the average depth of discourse was no more than a few steps. It appears that the purpose of the fact-oriented discourse was to pose a simple question and to find the right answer quickly. This might be related partly to the issue of taking cognitive risks. It is much easier to find an answer to factual questions than it is to answer questions seeking understanding. This pattern of discourse provides evidence for the position that collaboration does not always lead to shared, progressive articulation of partially developed ideas. Further, the pattern observed seems closely reflect school children's common practices of classroom interaction (see Lemke, 1990).

The third pattern of discourse found was explanation-oriented discourse. Characteristic to explanation-oriented discourse was that students asked explanation-seeking research questions (why, how come) and that explanations of collaborators were not taken as given but clarifications for statements and explanations were requested.

While conducting explanation-oriented discourse, students went beyond the information given, saw knowledge as problematic and something that needs to be explained, and actively used abstract and scientific concepts. In other words, objects of their comments were theories, ideas and methods of research, and the goal of discourse was pursuing understanding. From cognitive point of view it represented the most advanced pattern of discourse.

Our analysis revealed that elementary students are able, to some extent, to start a valuable discourse, even without a teacher's guidance. However, it appears that without external support from the teacher the students are not able to continue the challenging discourse. Explanation-oriented discourse, however, emerged rarely. This issue raises some pedagogically critical questions: How to expand progressive episodes of discourse, how to make them the prevailing mode of communication and how to make progress the standard for discourse.

Communication through collaborative learning environments is based entirely on written language. Thus the networked environments of CSCL encourage students to use writing as the main medium of collaborative learning and between-student communication. This is an important aspect because writing is essential tool of thinking in our present society (Bereiter & Scardamalia, 1987; Olson, 1994). It has a crucial significance in explication and articulation of one's conceptions. As a consequence, the externalization of ideas by writing, making thinking visible, is assumed to help students to reflect on their own and others' ideas and share their expertise. However, in many cases students of lower grade levels are not necessarily fluent writers and readers and might have difficulties to learn by participating in forums that require them to express their thoughts as text (Roschelle & Pea, 1999; Lipponen, 1999; Lipponen, Hakkarainen, Muukkonen & Rahikainen, 1999). Further, communicating with "faceless partners", is very different from the face-to-face communication. Especially the process of building common knowledge and grounding is very demanding through written language. Studies on learning interaction report difficulties in reaching common understandings even in face-to-face teaching-learning situations (Winne & Marx, 1982). As stated by Clark and Brennan (1991) grounding changes with the medium because techniques available in one medium may not be available in another. In written language explicating the referential relations of message creates context and grounding; in contrast these are usually known by participants or are easily checked in face-to-face communication.

If one examines notes posted by Finnish students to CSILE's database, one notices that these usually consist of only a few sentences. To illustrate this phenomenon all the sentences and words produced by the third grade students' (N = 24) and fifth grade students (N = 27) to the CSILE database during one project were calculated. Results show that three graders produced 143 CSILE notes, containing 320 sentences (M = 2.24, SD = 2.43) and 2107 words (M = 14.73, SD = 22.26) to database. The fifth grade students' produced 155 CSILE notes, containing 254 sentences (M = 1.64, SD = .99) and 1947 words (M = 12.56, SD = 8.89) to database.

Moreover, examination of our CSILE students' communication indicated that in many cases the students did not explicate such referential relations (see excerpts 7, 8, 9). In this respect, their written activity resembled oral discourse (Lipponen & Hakkarainen, 1997; Lipponen & Hakkarainen, 1998). However, these considerations of written discourse do not necessarily lead to a bleak outlook. It is possible that, to some degree, students' noninvolvement with writing arises from their distaste of standard classroom practice and their exposure to computer environments that demand only non-writing activities. To the extent that the student attitudes and skills mentioned above are effects of the present pedagogical and technical systems, they perhaps can be changed with exposure to new teaching methods and new technological environments. In addition, students are not usually required to write extensively at school. Traditionally the audience of writing has almost always been the teacher, and the function of writing with which they are most familiar has been to demonstrate that one has understood assigned texts and acquired desired knowledge (Geisler, 1994). Students are not encouraged to use writing for articulating and sharing their ideas and extensive thinking is not facilitated through writing assignments; such assignments do not usually require production of more than one or two paragraphs. Presumably, as a consequence of such practices regarding writing at school, students do not generally, use writing to build knowledge while working with CSILE. A study conducted by Hakkarainen (1998) gives, at least partly, support for the conclusion that the difficulty of making thinking visible by writing depends on culture of writing and that the culture of writing can vary form class to another, even at the same school.

Participation. Ogata and Yano (1998) defined three forms of participation in computer supported collaborative learning environments: 1) Observational participant is a learner who only observes a discussion without utterances; Direct participant is a learner who joins in a discussion and his/her opinions are shared and can be discussed by all of the participants of the same discussion team; 3) Indirect participant: In this case, an observational participant interacts with direct participants of any discussion team but without going any particular team. The learner may concurrently participate in multiple collaboration by combining different kinds of participation. To augmenting participation in collaboration, educational groupware systems should support observational, direct and indirect participation. Our focus was on students' direct participation. Our case studies showed, that participating in computer supported collaborative learning within the CSILE network was particularly motivating for Finnish male students (Lipponen & Hakkarainen, 1997). In most of the CSILE projects, boys were more active, i.e., posting more notes to the CSILE database than the girls (this does not say anything about the quality of knowledge produced). A good illustration of this is the data collected from a four-week course on "Energy" consisted of CSILE students' (fifth graders, 11-12-year-old students) notes posted to CSILE database.
During the energy-project, students (N= 27, female, n = 13 and male, n = 14), posted 141 notes to CSILE database from which girls posted 41 notes (relative proportion of female students notes was 29,5 %) and boys posted 100 notes (relative proportion of male students' notes was 70,5 %). Further, there were several projects where some students did not produce any CSILE notes; for example during the Energy project conducted by teacher A, six (4 females, 2 males, N = 27) students did not make any posting to CSILE database. As opposed to this, in one project each of four male students (N = 26) produced over 100 notes (N = 1159) to the database.

Many other studies also show that boys feel more positively towards computer use, and also find computers more attractive than girls find. Girls seem to have less motivation to work with computers. On the other hand the empirical studies offer quite contradictory conclusions about the impact of gender in computer supported learning (Barbierri & Light 1992; Hakkarainen, 1998; Healey, Pozzi & Hoyles, 1995; Hoyles 1988; Littleton, Light, Joiner & Barnes, 1992; Palonen and Hakkarainen 1999). Students' uneven participation activity in traditional classroom learning and classroom discussions is a well-known issue (Eraut, 1995). However, the promise of networked learning environments has been that they will democratize the participation activity of students. According to our studies CSCL only gives students possibilities for equal participation. Whether these possibilities are ever realized depends on context and educators' practice. In addition, the gender differences might reflect a shift in which CSCL is motivating and "favoring" different students than does traditional schoolwork. Perhaps, as Hoyles and Forman (1995) pointed out, maybe too little attention is still paid to topics like friendship, class, culture, and gender in computer supported learning.

Motivation. Technology-based learning environments seems to foster productive task-related interactions and enhance effective motivation (Järvelä, 1998). Hence, The general claim of

CSCL has been that the networked learning environments provide a common, and mostly optimal, experience for all students. However, in order to explain and understand the cognitive advantages and challenges of computer-supported collaborative learning a detailed exploration concerning an individual student's ways to cope (for example the dynamic interplay of personal beliefs, situational interpretations, subsequent actions) in new learning environments is needed. A crucial question is who profits from CSCL. It can be presumed that CSCL application never provides precisely the same benefit to every student, but individual profits depend on preferences, prior experience, roles, and assignments (Järvelä, Niemivirta & Hakkarainen, 1999; Lehtinen et al., 1999; Rahikainen, Hakkarainen, Lipponen, & Lehtinen, 1999). In fact, only a few studies have been reporting students engagement in computer supported collaborative learning from the motivational point of view (see for example Hakkarainen, et al., 1999; Järvelä, Niemivirta, & Hakkarainen, 1999; Rahikainen, Järvelä & Salovaara, 1999).

Our analysis showed that students were very motivated to work with CSCL. However, it was obvious that this new learning situation brought up new motivational challenges. One might, for example, have expected learning-oriented or high-achieving students to process and produce conceptually more sophisticated knowledge than performance-oriented and avoidance-oriented students in CSCL.

However, regardless of their motivational orientation or school achievements, Finnish CSILE students tended to produce the same kind of descriptive, empirical, and factual knowledge (Hakkarainen et al., 1999; Järvelä, Hakkarainen, Lipponen, Niemivirta, & Lehtinen, 1997;). "High motivation" measured in traditional terms did not seem to strongly promote the type of inquiry-based and collaborative activities under examination.

Further, the results of the on-line motivational analyses did not point out considerable changes in the students' motivational orientations during CSILE work. Still, a slight increase in the performance orientation among the students can be seen. Working with CSILE seemed to facilitate non-learning-oriented students' active task-related participation In one of our studies (Lipponen & Hakkarainen, 1998) two below-average students, both males, who represent avoidance orientation as their socio-emotional coping strategy and who were passive in traditional classroom discussions participated very actively in CSILE. However, this active participation was not closely associated with a high quality of knowledge produced. On the other hand, the studies showed that, in general, students with non-learning orientation had difficulties to cope with computer supported collaborative. One possible reason might be, comparing CSCL to traditional classroom learning, the less structured nature of the learning activities and lack of obvious learning goals posed by the teacher.

The analysis support the assumption, that non-learning-oriented students need strong scaffolding from the teacher in order to cope with the challenges of CSCL more sufficient way. Moreover, as stated earlier, computer supported collaborative learning was particularly motivating for Finnish male students.

CONCLUSIONS

The aim of the article was to review the educational use of CSCL, in particular the CSILE set-up, based on several Finnish empirical case studies at the elementary and secondary level. The case studies were conducted in two Finnish classes. Therefore, the results do not necessarily yield directly comparative data for differing cultures of using CSCL in countries other than Finland. However, it is also possible that these challenges are, to some degree, universal and every project seriously concerned with promoting educational change through CSCL will have to find ways of meeting these challenges. The analysis indicates that in order to use CSCL in normal schools several challenges have to be met, especially pedagogical ones.

In conclusion, it may be useful to discuss the pedagogical challenges of CSCL by distinguishing between first-order and second- order effects of educational technology. Our studies would appear to indicate that the introduction of computers itself affects the nature of the whole learning environment. These effects, which we call "first-order" effects of educational technology, refer to learning of skills of using information technology, developing skills of basic knowledge acquisition, generally increased motivation, and accessing extended sources of information. First order effects also involve changes in structures of classroom activities and changed division of cognitive labor between the teacher and the students. Our evidence clearly indicates that the structure of classroom activity changed after the introduction of CSILE. Students were working in a more self-regulated way; they were doing tasks more on their own and directing their own projects instead of following detailed assignments of the teachers.

It seems that the first-order effects are normal consequences of engagement with computer supported collaborative learning. However, they do not, as such, facilitate social construction of knowledge and advancement of the students' deeper, principled and conceptual understanding, which depends critically on the appropriate supportive activities of teachers, especially their involvement in new roles. Thus a very critical aspect of facilitating pedagogically meaningful use of ICT and practices of CSCL is training of teachers. It may be that in the beginning of our research project we did not provide enough support for he teachers. Recently we have radically increased the amount of training and support given to our teachers. The first-order effects, of course, may be pedagogically very valuable achievements and represent a significant improvement over traditional practices of learning and instruction.

While analyzing the CSCL practices of Finnish elementary students a critical stand was taken. However, the results should not be interpreted as negative evidence against CSCL. Even if the Finnish CSILE students in present studies to date did not achieve higher-level processes of collaboration, the practices of learning and instruction changed considerably, representing a significant improvement over traditional practices of learning and instruction. Students were working in a more self-regulated way, directing their own projects instead of following detailed assignments of the teachers, and the amount and quality of social interaction among students and between teachers and students increased. Further, students learned skills of using information technology, developed skills of basic knowledge acquisition, learned access extended sources of information, and in general their motivation increased.

However, bringing computers into the classroom does not automatically lead to what we call second-order effects of educational technology. The second-order effects involve engaging students in a sustained question- and explanation-driven inquiry, true knowledge building, and progressive discourse analogous to scientific practice. The second-order effects may lead to a profound change in the students' conceptions of what learning and knowledge are all about, and they need strong pedagogical support from the teacher. The second-order effects appear, further, to require deep change in teachers' conceptions of knowledge and in the pedagogical practices of school generally. This appears to be very difficult to achieve. Perhaps the theoretical and practical principles of CSCL are still too recently articulated to be widely recognized and applied in practical educational reforms.

In order to facilitate CSCL in elementary-level education, a substantial change in pedagogical practices and in the wider culture of schooling is needed. Nevertheless, the culture of school learning cannot be expected to change immediately but presupposes a long process of exploring and testing different cognitive and pedagogical practices, such process necessarily involving educational personnel. The change also demands the educational policy to seek and foster these changes. The challenges for CSCL arise from the fact that we are, simultaneously, trying to promote educational use of the new information and communication technology and implement new pedagogical and cognitive practices of learning and instruction. Although the new technology and pedagogical ideas support each other, the change demands the utmost of both teachers and students.

4.3 TEACHER GUIDANCE DURING COMPUTER SUPPORTED COLLABORATIVE LEARNING

Henny Van der Meijden

INTRODUCTION

Introducing a new concept of learning, influences the educational system on all levels, macro-, meso- and micro level, in a high degree. The implementation of Computer Supported Collaborative Learning (CSCL) should be considered in the various levels of the educational system. In this part, we only take into account the micro level, the role of the teacher and the teacher guidance by the researchers of this project. The role of the teacher is described in another part of this project namely the Starters Kit for Teachers (Verschaffel, Lowyck, De Corte, Dhert, Vandeput, 1998).Computer Supported Collaborative Learning changes the work of the teacher dramatically on different levels. Instead of asking questions to the students, the teacher has to reply the questions from the students, or guide the students in such a way that they find their own answers. Teachers act more as guides and tutors, intervening if necessary, giving individual feedback as much as possible and acting as facilitator, more than playing the role of the content expert. Teachers in a CSCL environment also have to deal with technical problems, related to the specific technology used. Developing learning materials and learning tasks for a CSCL environment requires considerable attention and time (Dillemans, Lowyck, Van der Perre, Claeys, Elen, (1999). In fact teachers have to deal with two different layers on which they have to build their class management: managing new technologies and managing learning groups.Changes in the classroom structure as a consequence of schools that have adopted a fully integrated technology are listed by Collins (in Dillemans et al. 1999, p.75):

- from whole class to small group instruction;
- from lecture and recitation to coaching (teacher's role from "sage on the stage" to 'guide on the side");
- from working with better students to working with weaker students, facilitated by student-directed learning;
- toward more engaged students;
- from assessment based on test performance to assessment based on products, progress and effort;
- from a competitive to a co-operative social structure;
- from all students learning the same thing to different students learning different things;
- from the primacy of verbal thinking to the integration of visual and verbal thinking, with organisational, artistic, leadership and other skills contributing valuably to group projects.

Authors in the field of co-operative learning, (Slavin, 1996; Cohen, 1994)have described important issues for the management of learning groups in co-operative learning task:

- group size and group composition
- reciprocal interdependence
- social interaction
- social skills
- group processes and evaluation
- individual accountability

These publications concentrate on group management activities in co-operative learning situations, where no attention is paid to the impact of technology. "Even when publications directly tackle teacher roles in ICT-based environments, elements for (technology-supported) classroom management are only implicitly provided." (Dillemans et al. 1999, p.77)

The impact of technology automatically means that information is available far outside the usual textbooks. Teachers will spend less time on searching information for their classes, but will spend more time on other activities. According to Menges in Dillemans et al. 1999) in the activities from the teacher following shifts are expected:

- from covering material to assisting students in sampling material
- from defining what has to be known to negotiating criteria that identify what is important
- from ranking students relative to one another to negotiating standards specific to individuals in terms of a "personal contract'
- from grading according to individual attainments to grading according to collaborative contributions
- from merely verifying student sources to deriving standards for fair use and credit
- from requiring students to reproduce knowledge to rewarding them for demonstrating originality

The software programs used in the CL-Net project all support a concept of knowledge as a human (collaborative) construction and a socio-cultural interaction between 'experts' and 'novices' (like in scientific research communities), putting individual thinking in a wider, social context. The applications can be seen as tools for creating a virtual multimedia community of learners, in which learning is to be seen as a constructive, authentic, situated (real life) and collaborative process, by offering a powerful learning environment (Dillemans, et al., 1998). In this environment, the teachers act as a facilitator and a process controller. His role as subject matter expert is 'on demand only' (a shift from 'instruction' to 'learning support' occurs). It has been evidenced that the teachers' role is no longer concentrated around the delivery of information within an isolated subject-matter field. Since learners become the 'architects' of their own knowledge, the teacher is conceived of as a coach, a guide or a manager of genuine learning processes of individuals and groups (Verschaffel et al., 1998). Consequently, the task of a teacher is complemented with new competencies, like information-management, time-management and group-management. In addition, putting the learner at the centre of the teaching/learning process refers to the teachers' ability in helping learners to follow their own learning route, to offer just-in-time feedback on their knowledge construction, and to scaffold them when they encounter difficulties as novices in many fields, like searching, selecting, processing and reporting information, working adequately in groups, and (co-) constructing meaningful knowledge. It must be clear that, in the perspective of discovery learning with a high level of self-regulation and openness, the involvement of the teacher fades as pupils or students grow stronger in managing their own learning process. This includes that learning from experience and errors (own and others) are an integrated part of the process, and that there is room for multifaceted individual differences.

During the CL Net project the researchers and teachers worked strongly together. Most of the teachers were not acquainted with collaborative learning with or without computers. As may be concluded from this short theoretical overview on teachers' role during CSCL, much was required from the teachers. Researchers tried in different ways to guide the teachers during the project.

TEACHER TRAINING

The classroom culture of the countries involved was more or less the same in all countries: rather teacher centred, with typical discourse patterns: the teacher asks questions and the

students try to answer these questions. Teachers are mainly concerned about classroom management. In none of the schools involved in the CL net project existed a tradition of collaborative learning. Some schools did not have sufficient hardware during the project.
In all countries teachers involved were given an introduction on the CL net project, the theoretical backgrounds, the experiments planned and the teachers' role required. Software user manuals were made for the teachers. During the experiments researchers frequently assisted the classes or were on line connected.

BELGIUM

School	1 primary
Classes:	4
Level:	5- and 6-grade
Teachers:	4
Domain:	mathematics
Computers:	1 per class (sometimes making use of the computer classroom of the adjacent secondary school)
Computer experience teachers:	drill and practice, Internet only 1 of 4 teachers
Used software	Knowledge Forum
Learning tasks:	developed by researchers
Feed back during experiments:	researchers (represented by a strip-figure: FIXIT)
Class management:	teachers

TEACHER TRAINING BEFORE THE ACTUAL START OF THE PROGRAM

Several two-hour meetings attended by the four teachers, their headmaster, and members of the research team. In the first meeting the project was introduced and discussed. In the second meeting the teachers were confronted with a model of competent word problem solving. In the third meeting, Knowledge Forum was introduced and teachers in pairs took the opportunity to work with the program. In the last meeting the experiences of the teachers were discussed and practical arrangements were made for the implementation of the learning environment in the classrooms.
All teachers and some researchers took part in a symposium, organised by the University of Nijmegen on this project in June 1998. The headmaster assisted to the international teacher meeting in Rome, December 1999.

Teacher support during the program

A Knowledge Forum database for teachers was installed, consisting of three parts: background information and guidelines, discussion forum, were teachers and researchers could exchange their experiences and the "hotline", were practical arrangements were made and the material was tested. A specific teacher guide for each lesson was provided, containing the overall lesson plan with the mathematics application problem to be addresses and specific suggestions for appropriate teacher interventions. All necessary concrete teaching and learning materials were provided: worksheets, problem notes, reaction notes etc.

TEACHERS' EVALUATION

All the teachers were very positive about their participation in the project. While at the start they were rather sceptical and anxious, once they became familiar with the new approach and once it became clear what kinds of support they would get from the researchers, they became enthusiastic. All teachers declared that they had learned a lot, that they wanted to continue to work with KF, also in other domains, and that they wanted to intensify the collaboration with the other classes and with other schools.

The enthusiasm had been seriously put to the test by the high amount of workload, the classroom management problems they had experienced realising a radical educational innovation in their rather traditional classroom practice and the numerous technical problems they had encountered during the project.

Finland

HELSINKI

School:	1 comprehensive school
Classes:	1
Level:	4-grade
Teachers:	1
Domain:	Biology
Computers:	
Computer experience teachers:	1 year experience with CSCL
Used software:	CSILE
Learning tasks:	supported by researchers
Feed back during experiments:	teachers (scaffolding)
Class management:	teachers (researchers present for technical support)

OULU

School:	1
Classes:	2
Level:	7-grade comprehensive school
Teachers:	2
Domain:	Chemistry and Literacy
Computers:	6 per class
Computer experience teachers:	chemistry-teacher: 2 years experience with CSCL
	Literacy-teacher: no experience with CSCL
Used software:	CSILE
Learning tasks:	supported by researchers
Feed back during experiments:	teachers (scaffolding)
Class management:	teachers

Teacher training before the actual start of the program

In all Finnish projects several plenary meetings were organised both before the start of the program as well as during the program. All teachers attended to an introduction to the pedagogical model used in the projects. Teachers got acquainted with this model of progressive inquiry, which emphasises the importance of engaging students in processes of question- and explanation-driven inquiry by imitating practices of scientific research communities. A guidebook was published: "How to carry out computer supported inquiry project”. Plenary meetings also took place during the program. Also meetings with individual teachers took place.

TEACHER SUPPORT DURING THE PROGRAM

The Finnish test-sites had a similar system for structuring the project. The teacher of the class controlled the project with the help of the researchers involved in these projects. The researchers did not teach, but provided support for the teacher in case of didactics concerning different phases of the project. Researchers were present during the lessons, but only for collecting data, videotaping students and teacher and making general observations. Interventions in pedagogical sense during class were avoided.

TEACHERS’ EVALUATION

Also the Finnish teachers were sceptical at the beginning. The project conflicted with the traditional curriculum. It was very time-consuming to be fully aware of the proceedings of each student, in order to scaffold on the optimal level: scaffolds should not be neither too demanding nor too obvious. The Helsinki biology-teacher missed the support of other teachers, because he was the only teacher using CSILE in his school. To share his ideas with the researchers was essential for the project. When the problems of the initial phase were over, all teachers were very enthusiastic about the project and the learning outcomes of their students.

Italy

ROME “CALVINO”

Schools:	1 primary
Classes:	1
Level:	4-grade
Teachers:	2
Domain:	history
Computers:	computer laboratory with 7 computers
Computer experience teachers:	one teacher expert in multimedia, other teacher only basic computer knowledge
Used software:	Discover your town, Our world
Learning tasks:	teachers and researchers
Feed back during experiments:	
Class management:	teachers (researchers present to gather material or videotaping)
Experience with collaboration	Calvino-school was involved in national organisation fostering the pedagogical approach based on collaboration

ROME, “FERRINI”

Schools:	1 primary
Classes:	2
Level:	5-grade

Teachers:	3
Domain:	history
Computers:	multimedia laboratory with 12 computers
Computer experience teachers:	3 teachers with no computer experience
Used software:	Discover your town, Our world
Learning tasks:	teachers and researchers
Feed back during experiments:	
Class management:	teachers (researchers present to gather material or videotaping)
Experience with collaboration	experience with collaboration

ROME, "SEVERO"

Schools:	1 secondary
Classes:	1
Level:	6-grade
Teachers:	2
Domain:	history
Computers:	no computers connected to the Internet
Computer experience teachers:	2 teachers without experience with the Internet
Used software:	Discover your town, Our world
Learning tasks:	teachers and researchers
Feed back during experiments:	
Class management:	teachers (researchers present to gather material or videotaping)
Experience with collaboration	no experience with collaboration

BARI, "MAZZINI"

Schools	1 primary
Classes:	1 group (in fact all 4-graders involved)
Level:	4-grade
Teachers:	9
Domain:	history
Computers:	computer laboratory with 2 computers
Computer experience teachers:	no experience
Used software :	Discover your town, Our Castle
Learning tasks:	teachers and researchers
Feed back during experiments:	
Class management:	teachers (researchers present to gather material or videotaping)
Experience with collaboration	experience in collaborative work and projects

BARI, "AZZARITA"

Schools	1 secondary
Classes:	1 class
Level:	7-grade
Teachers:	
Domain:	history
Computers:	computer laboratory with 20 computers
Computer experience teachers:	all teachers had experience
Used software :	Discover your town, Our Castle

Learning tasks:	teachers and researchers
Feed back during experiments:	
Class management:	teachers (researchers present to gather material or videotaping)
Experience with collaboration	experience in collaborative work and projects

Teacher training before the actual start of the program:
There were two meetings in May and June 1998 in order to verify teachers' interest in participating in the project. In September 1998 a one-day meeting with both Bari teachers and Rome teachers was organised. This meeting was very important to implement communication between teachers from different schools and towns. A communication network using e-mail and the Internet was installed.

TEACHER SUPPORT DURING THE PROJECT

During September 1998 till June 1999 a large number of meetings have been organised. Meetings among teachers from the same site, from the same town, two national meetings and one international meeting (Rome) were organised. The local meetings in Rome took place once a month for the whole group and every two weeks for the sub-groups in each of the two schools in Rome.

TEACHERS' EVALUATION

All teachers think that collaboration between students increased during the activities with the software *Discover your town*. Teachers of the junior secondary school in Rome (6th grade) observed good results both for learning and motivation. Children were really interested in the activity that was more interactive and gave more autonomy to children than usual school activity. Children could work autonomously in little groups, working with great responsibility. Also in the two primary school in Rome teachers noted that children worked very well both in dyads and in little or big groups. In Bari primary school teachers observed a clear improvement in children's relationships in terms of being more open to listen to others, and in terms of tendency to negotiate navigation strategies with their partners. In the junior secondary school of Bari, teachers observed some interaction problems during the project-activities.

GREECE

School	1 private primary
Classes:	5
Level:	6-grade
Teachers:	5
Domain:	science (solar system)
Computers:	
Computer experience teachers:	
Used software :	Knowledge Forum
Learning tasks:	teachers and researchers
Feed back during experiments:	teachers and researchers
Class management:	teachers and researchers
Experience with collaboration:	no experience

TEACHER TRAINING BEFORE THE ACTUAL START OF THE PROJECT

A small conference took place at the beginning. Four experts, two from the collaborating countries and two working in similar projects in Canada and the United States presented their

work. The emphasis on collaborative learning was quite new for most of the teachers. Before the actual start, teachers were given an introduction to the project, and an introduction to the software.
User manuals were given together with literature about conceptual changes. The teachers worked with the software program, supported by the computer teachers and the researchers.

Teacher support during the program
During the experiments the teacher-researcher communication was limited to brakes between and after the classes. No e-mail communication was possible due to lack of technology. During the second experiment an additional hour for discussing and co-designing was established. During the experiments the role of teacher and researcher was identical: guide the students not by answering directly their questions, but by showing them ways to find the answers, or direct their attention to gaps in their accounts. Students were not used to work together. To take over something from a peer was considered use-less or a theft. Teachers in many cases were asked to evaluate students' work.

TEACHERS' EVALUATION
The teacher had to play a new role that demands a change of old habits and attitudes on learning and relationships with students. This was a big change for the teachers and it was difficult to achieve this in such a short period. It is important to notice here that the Greek elementary school students are used to a very traditional, teacher-centred, rather authoritarian approach which does not provide them with many opportunities to express their opinions or to collaborate with other students. It is also remarkable that there were no disciplinary problems during the intervention despite the fact that this learning environment lowered the amount of teacher control that could be exercised and provided students with many opportunities to show lack of discipline if they wanted to do so. Finally, the students showed an aptness in learning the software, despite the fact that the commands were in English.

THE NETHERLANDS
AMSTERDAM

School	3 primary
Classes:	1 class per school
Level:	7- and 8-grade
Teachers:	3
Domain:	mathematics
Computers:	computer laboratories with 15 computers
Computer experience teachers:	all experienced teachers
Used software :	Knowledge Forum
Learning tasks:	one teacher and the researcher
Feed back during experiments:	one teacher and the researcher
Class management:	teachers
Experience with collaboration:	

WAGENINGEN

School	3 agricultural vocational education, food technology 2 agricultural vocational education, horticultural school
Classes:	5
Level:	1-,2-,3, grade
Teachers:	6
Domain:	management, conduct of agricultural produces

Computers:	
Computer experience teachers:	
Used software :	Knowledge Forum
Learning tasks:	teachers
Feed back during experiments:	teachers
Class management:	teachers and researchers
Experience with collaboration:	

NIJMEGEN

School	1 secondary
Classes:	5
Level:	3- and 4-grade
Teachers:	5
Domain:	biology, history, physics,
Computers:	20
Computer experience teachers:	1 ICT expert, 1 no experience, 3 basic knowledge
Used software :	Knowledge Forum
Learning tasks:	teachers and researchers
Feed back during experiments:	teachers and researchers
Class management:	teachers and researchers
Experience with collaboration:	no experience

TEACHER TRAINING BEFORE THE ACTUAL START OF THE PROJECT

The University of Nijmegen organised a plenary meeting with all the teachers involved in the project, in June 1998. Both Dutch and Belgium teachers assisted to this meeting. An introduction was given on Collaborative Networks in Europe, on educational backgrounds and on the results of Computer Supported Collaborative Learning. The software Knowledge Forum was introduced and teachers had the opportunity to discuss this program. A KF database for teachers was installed.

The three primary school teachers participating in the project also participated in the CIAO-project, which stands for Computers In Amsterdam educatiOn. In Amsterdam one of the teachers was a student in educational science. Together with the researcher he designed the activities for collaboration.

The test sites of the Wageningen University were located in different regions of the Netherlands. Before the experiments started the teachers were provided with a training which focused on the idea behind collaborative learning and learning communities, how to use Knowledge Forum and its possibilities (both technical and process oriented), how to start and sustain a collaborative learning process and how and when to intervene. A framework consisting of several steps was offered to the teachers as a guidance to make the assignments. The teachers were provided with a list of possible interventions. Because the different groups studied a variance of topics, the teachers had to decide themselves what content-specific interventions they had to make. Teachers of Wageningen assisted

the meeting in Nijmegen and also some of them the international meeting in Rome.

The teacher training for the Nijmegen test site started with the central introduction meeting for all the Dutch-speaking teachers from the Netherlands and Belgium in June 1998. After the central introduction meeting, the teachers from the Nijmegen project were given training in how to use Knowledge Forum. In several meetings researchers and teachers discussed the ideas behind Collaboration in general and specifically in Computer Supported Collaborative Learning, and how to introduce CSCL in their own education. Researchers and teachers in co-operation developed the course material.

TEACHER SUPPORT DURING THE PROGRAM

DURING THE EXPERIMENTS OF THE WAGENINGEN TEST SITES, THE TEACHERS HAD THE OPPORTUNITY TO ASK QUESTIONS ABOUT THE PROCESS AND HOW TO GUIDE IT (WHEN THE RESEARCHER WAS PRESENT OR BY E-MAIL OR PHONE). IF PROBLEMS OCCURRED TEACHERS AND RESEARCHER DISCUSSED THEM AND IF POSSIBLE SOLVED THEM COLLABORATIVELY.

On the Nijmegen test site, researchers always were present during the courses to assist in case of technical problems and to guide the teachers during and after class. In the second course the teachers were asked to participate more active in the database, during and after class, in order to foster more depth in the discussions

Teachers' evaluation

All Dutch teachers involved in the projects were interviewed after the experiments were finished. They all agree that Knowledge Forum is suitable for education. The primary schoolteachers however, find that written communication is very difficult for pupils with a minority background (one of the schools had an almost 100% population of an ethnic minority). A textual interface would have been preferable for the young children, although they did know how to use the program very easily, despite of the English language.

All Wageningen' teachers mentioned to have participated because they wanted to get acquainted with new forms of teaching and learning. They were positive about the process of knowledge building in which students think out loud, discuss their points of view, reflect on those of others, correct their own and others' existing misconceptions and offering help to gain and describe information about a certain topic. They judged the lack of ability of the students to use the Internet and the learning environment together with the technical problems like crashing servers to be the biggest obstacle to overcome in such experiments. They also mentioned unanimously that they spent more time supervising the students during their work then they were used to. But next to stating the larger amount of time spent on the support, they also mentioned that they were more aware of the problems and experiences the students had to cope with. They noticed that the students were higher motivated to work on the assignments, to search for more answers and solutions, to discuss several possible strategies and make more use of the knowledge they gathered in school.

All five Nijmegen teachers were interviewed. Their opinions on working with WKF can be summarised as follows: it is a transparent program, not difficult to work with, neither for students nor for teachers, although students not always use it correctly. The English language is not a problem for the students. Problems at the start were quickly solved. Although at the start some teachers were unfamiliar with collaboration in classroom teaching, by the end of the project, teachers were stimulated to use other forms of collaboration, with or without the computer, in their teaching. All teachers said that they would continue to work with the program and do some projects on CSCL, even when the support by the researchers stops.

CONCLUSIONS

Introducing CSCL into classroom teaching requires a great deal of teacher support. As has been pointed out before, the task of a teacher is complemented with new competencies, like information-management, time-management and group-management. The teacher must design the curriculum and monitor and manage its progress. Moreover he has to monitor the database and assess the depth of investigation that goes on. CSCL requires teachers' ability in helping learners to follow their own learning route, to offer just-in-time feedback on their knowledge construction, and to scaffold them when they encounter difficulties as novices in many fields, like searching, selecting, processing and reporting information, working adequately in groups, and (co-) constructing meaningful knowledge.

Technical support is also indispensable. Manuals on how to use the different software, training, technical support in case of a computer breakdown, guidelines for using the database for analysing the interaction (like Analytic Toolkit for Knowledge Forum), all kinds of support are necessary. Researchers of the CL net project have provided both pedagogical as technical support.

Collaboration between the teachers involved in the same project, working with the same software, is of great importance, teachers supporting teachers. Meetings between teachers (international, national, local and school meetings) give an opportunity to discuss problems and feelings, to meet partners and find commonalties, to involve more teachers into the project and to foster the perception of the role as researcher.

Financial support, for example computer equipment or extra hours for the teachers is desirable too, as well as support from the administration of different institution.

4.4 POSSIBLE ROLES OF INSTITUTIONS

Silvia Caravita, Henny van der Meijden,

INTRODUCTION

Recent developments have linked the educational use of technology with developments in learning theories. Much research indicates that educational use of ICT changes the classroom culture in many ways. To adapt to these changes turned out to be difficult, for both teachers and institutions.
The objectives of the CL-NET project envisage a deep change in the educational school intervention that cannot be viewed as a process restricted to the class teaching or learning environment but as a process, which requires re-thinking at many levels of the school institution. Although in each country the case studies carried out by the CL-NET partners have engaged few school classes and have focused their attention and control on those classes, it is quite relevant for the dissemination of the results to highlight the reactions of the institutional context in terms of facilitation or resistance to the changes that the experimental setting introduced.
A systemic approach to the interpretation of the outcomes of any action undertaken in the school suggests to take into account not only teachers' decisions and actions on a micro level, not only to see them in relationships to their professional competence, or to the resources made available to them. It is important to re-locate teachers within the network of relationships that includes the school community. Different levels, from the school institute organisation to the national educational system, have to be taken into account. Some conditioning factors on different levels are being pointed out here, sometimes quoting from the documents, to reflect more in depth upon the relationship between research and school change. The teachers' role and the pedagogical and organisational issues have been described more specific elsewhere in this report.

Participation in national projects

Some of the case studies described in this report were "embedded" within on-going institutional interventions on a wider scale. These plans range from merely funding the schools for computer equipment to develop and implement school practices supported by technologies, as it is exemplified here.
The three elementary schools of the Amsterdam site also participated in the CIAO-project (Computers In Amsterdam Education) that focuses on offering access to a range of educational ICT-applications, technical and didactical support. The Dutch secondary school was a so-called pioneer school, a school that receives extra money from the National Department of Education to introduce computers in the curriculum. And in Italy the computer laboratories in the schools of the experimental sites had been equipped with funds of the national plan of the Ministry of Education, which included also ICT courses for teachers. In Finland support was provided by the City of Helsinki-project, a major information technology project that stimulated students from elementary to high-school level to gain skills needed for productively functioning in a knowledge-based society. This project concerned also the research focused on analysing pedagogical effects of the overall project as well as analysing and exploiting innovative pedagogical practices through intensive case studies on computer-supported collaborative learning.

To a certain extent the sites mentioned above were supported (at least for the equipment) by institutional interventions that pursued similar goals. In Greece and in Belgium the CL-NET projects were not related with larger institutional plans, but they relied on agreements between school institutes and University Departments. In Greece the selected institute was a private school. The Belgium school was a school functioning as training school for the Department of Teacher Education.
In general it seems that little synergy occurred between national or local school authorities responsible for the larger projects and the experimental projects. Very little was done to facilitate the re-structuring of the school practice, even in situations that could be considered as opportunities for testing changes under protected conditions.

SCHOOL PARTICIPATION

Curriculum

The project was experienced as an extra-curricular activity: teachers and researchers were more or less given a "carte blanche" to implement the learning environment. The sole condition was that teachers had to finish the formal and official curriculum. In that respect the content of the implemented learning environment in the majority of the cases was a surplus on and an add-to that formal (and national) curriculum. The problem of two curricula appeared to be very common in classes that were implementing or using new technologies. The traditional information-transmission curriculum seemed to co-exist side by side to the open learning environment.
In the Italian secondary school the daily time schedule is more rigid than in elementary school: because subject matters are many and their teachers rotate among many classes. The teachers of classes who participated in OUR WORLD project in Rome met great resistance in colleagues when they tried to negotiate changes since they needed extended time for activities outdoor or in the computer laboratory. Formal requests of change implied complex bureaucratic procedures.

TEACHERS AS RESEARCHERS

Teachers were also involved as co-researchers in documenting the work, in answering interviews, in participating in the interpretation of the protocols. In most cases, teachers did not receive any formal recognition for this work from the school. All this workload added on (and was not subtracted from) the time spent in the other many meetings currently organised in the school, in Italy at least. Teachers could not apply for any re-funding for the expenses necessary to participate in meetings with the European partners of the CL-NET projects.
The construction of a community of learners which goes beyond the class borders, the access to sources of information different from textbooks and including communication with territorial institutions require a great amount of time. A particular need of co-ordination among teachers appeared quite evident in those projects that encouraged exchanges across schools. This job had to be undertaken by the research group since it was not realistic to expect it from one of the teachers. The educational system does not consider these kind of innovations as a reality of the teachers' profession and provide time to reflect on the practice, discuss and re-elaborate these innovations, still is considered as optional and a luxury.

To a certain extent, schools perceive experimental projects like CL-NET as external, as originating from motivation of agencies that pursue objectives related with scientific investigation, as accepted by the head of the institute for the school prestige, but not as a really productive tool for the benefit of their own school community.

Obviously this has nothing to do with the quality of the relationships that researchers established with the teachers in the experimental sites: comments expressing satisfaction for the close and good collaboration that took place can be found in the report of each country.

School administration

The administrations of the schools involved in the CL-NET experimental sites gave their enthusiastic adhesion to the project and the participated in the meetings with teachers, at least in the initial phase. Concrete actions to support the project were not always that incisive, though. Relieving some of the teachers' responsibilities, facilitating circulation of information, involving the community were interventions practised to a limited extent. It has not been explicated in all the reports how the choice of the teachers and classes that had to be involved in the experimentation was influenced by the administration of the schools. In some cases the administrations asked to involve more classes than researchers desired; they motivated their request either with concerns about disrupting teams of teachers or parallel classes already established, either with worries about parents' reactions to the "exclusion" of students. Anyway less motivated teachers did not positively contribute to the development of the project and even less to its dissemination within the community. Certainly administrations view collaboration with scientific institutions as a resource for their institute and they have objectives that they want to pursue which are entrenched in the local situation.

School organisation

The teacher staff of elementary and junior high schools does not include teachers who are responsible for departments or who can manage activities for the whole school community. The formal rules for seconding teachers from the teaching activity to appoint them to co-ordinating roles within the school are very strict and school participation in an experimental project (even if approved by the school authorities) is not a sufficient condition. Departments take care of subjects or have the responsibility for territorial relationships or for different aspects of the school educational policy, such as school drop, integration of immigrants, etc. The interaction between the department, the teachers and the researchers was not integrated. Of course there are tight schedules in the school. There was no time arranged for interactions among the different constituents of the school. In some experimental sites only one teacher was involved. There was no opportunity for communication with other teachers within the same school, and no real discussion about the pedagogical approaches (Finland).In the Italian case study about "Our World" the integration between the teachers of two subject areas (scientific and linguistic) was very problematic. Notwithstanding the program offered great opportunities for situating language teaching into authentic communicative tasks, the language teachers almost ignored the new inputs introduced in the learning environment and interpreted them as just related with environmental education, therefore not of their concern and responsibility.

Technology

In many cases, particularly in primary schools, the teachers and researchers had to face problems by the poor equipment (quantity and quality of computers connected to the Internet), by the lack of assistance in case of technological breakdowns, by the absence of ICT teachers and the availability of computer classes. Despite all that, the general impression from the reports is that the technical setting was satisfying in most cases.

Teachers themselves stresses more the role of infrastructure and their ability in using technology than the role of pedagogical principles, when asked about the conditions to be fulfilled in order to effectively implement the CL-NET project in their school

RECOMMENDATIONS

- The level of the IT infrastructure is not yet sufficient, especially when the use of ICT is considered as pedagogically well based. Computers and computer networks will not be utilised optimally if appropriate learning materials are missing. Technology is getting more and more complex, maintenance must be transferred to experts in IT so that teachers can do what they supposed to do, namely provide pedagogical support (Sinko, Lehtinen, 1999).
- School libraries should become more and more the centre of the school and should become (multi)mediatheques. In that case, the role of the librarians will change completely, from merely a person for checking in and out books, to a tutor and a guide in the search for information. Equipment should be placed so that students can work alone and in small groups (Dillemans, et al. 1998)
- Teacher training must be increased, teachers at all levels need more technical know-how and expertise. Teachers also need to be trained in being a guide and tutor, and not merely the transmitter of information. Teachers should be supported in the creation of electronic communities. In that way they will develop new learning methods and form their own learning community.
- Institutions present in the school territory, not only scientific institutions, are attracting the attention of the school and will increasingly participate in the educational community in the future. Opening the schools to activities beyond the school time might facilitate this encounter.
- Integration between educational research and the policy of the national school institutions is necessary: experimental work should be a valued part of programs and plans to innovate the educational system. School administration, scientific institutions and school authorities should all be concretely involved in defining the needs of an ecologically valid experimental setting prospectively aimed at dissemination. Supporting teachers to disseminate the practices that they have acquired can make them feel ownership and pride about innovations they contributed to promote. As long as this kind of collaboration not has been realised, even researchers will have hard times in justifying to their institutions the time and energy spent within the school to "construct" the artificial change that is the source of the data that they want to collect. Research questions risks to be disconnected from the actual school life, the outcomes of investigations scarcely affect the change of the system.

Teachers possess the key to the success of the use of computer technologies. Computers, software and pedagogical support must be provided as well as adequate training for teachers. Technology must be adaptable to the instructional needs of the teachers and to the daily realities of classroom life. Therefore the support from schools and institutions on different levels is indispensable.

5. DISSEMINATION OF THE RESULTS OF THE CL NET

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OTHER ASPECTS OF DISSEMINATION OF RESULTS

Finland

Some results of CSCL-project in Länsimäki were reported as a part of a larger study report 'Studies of Organisational Change' for OECD/CERI. The report of Länsimäki School was a Finnish pilot study. Presentations and workshops were held during at least four national conferences and also some minor 'training days' for teachers and other education-related people as well as public lectures. Publication of a guidebook for teachers and some reports (both in Finnish). Collaboration with some participating schools still exists, some schools have continued the projects by themselves.

Greece

One researcher currently is teaching high school teachers (36, 15 last year and 20 this year) that are going to support the introduction of ICT technologies in schools, a class on the pedagogical applications of the Network technologies. During this course they are not only using Web Knowledge Forum but we are also discussing about our (and similar research) so that they have an informed opinion about the introduction of such CSCL in the schools.

These high school teachers are each going to be responsible for supporting the introduction of new technologies in all of the curricular courses for 5 high schools.

Italy
In italy different researchers from different intitutions gave different workshops:
Workshops at the Post-laurem course for secondary school teachers (Rome)
Workshops at the Post-graduated private course in New Technology for teachers (Bari)
Workshops at the Psychology course at the University of Rome 2000-2001

The Netherlands
In the Amsterdam CIAO-network of Amsterdam primary schools (50 schools) series of workshops are given on computer-supported collaborative learning using the results of CL-net. In Nijmegen CSCL has become part of the normal curriculum in University teaching (Department of Education, courses: co-operative learning, and ICT in education) The school that was involved in the CL NET still is using Web Knowledge Forum in different classes even without support of the researchers.
Some of the schools of the vocational agricultural education, (Wageningen Agricultural University) still use Web Knowledge Forum in classes, without any further support.

PROJECTS

EUROPEAN: ITCOLE: Innovative Technology for Collaborative Learning and Knowledge Building (EC: IST programme, EN F 2 FP5RTD)
NATIONAL: The Netherlands: Collaborative and productive learning in groupware and 3-D virtual worlds

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