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AUTHOR	Salovaara, Hanna; Salo, Piritta; Rahikainen, Marjaana; Lipponen, Lasse; Jarvela, Sanna
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ABSTRACT

There are indications that Computer Supported Collaborative Learning (CSCL) and accompanying inquiry-based pedagogical practices can enhance student learning. The aim of this study is to experiment CSCL and inquiry-based approach in real classroom situations and to analyze students' approaches in inquiry process in terms of cognitive and motivational engagement. Two elementary school classes participated in the study. One of them was a lower elementary school class (21 students, age 10-11) who participated in CSCL inquiry in natural science and the other was an upper elementary school class (18 students, age 13-14) who participated in CSCL inquiry in literature. The data consists of students' written computer notes, students' interviews, video recordings, and self-reported motivational orientations. The results indicate the possibilities of enhancing students' learning in literature and in natural sciences by CSCL inquiries. However, the results also reveal failings in students' inquiries, for example, the dominance of superficial approach to inquiry. (Contains 26 references.) (Author/AEF)

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Developing technology-supported inquiry practices in two comprehensive school classrooms

Hanna Salovaara
University of Oulu
P.O.Box 2000
90014 Oulun Yliopisto, Finland
hsalovaa@ktk.oulu.fi

Piritta Salo
University of Oulu Finland

Marjaana Rahikainen
University of Turku, Finland

Lasse Lipponen
University of Helsinki, Finland

Sanna Järvelä
University of Oulu, Finlans

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Abstract: There is indication that Computer Supported Collaborative Learning (CSCL) and accompanied inquiry-based pedagogical practices can enhance student learning. The aim of this study is to experiment CSCL and inquiry-based approach in real classroom situations and to analyse students' approaches in inquiry process in terms of cognitive and motivational engagement. Two elementary school classes participated in the study. The one of them was lower elementary school class (21 students, age 10-11) who participated in CSCL inquiry in natural science and the other was upper elementary school class (18 students, age 13-14) who participated in CSCL inquiry in literature. The data consists of students' written computer notes, students' interviews, video -reported motivational orientations. The results indicate the possibilities of enhancing students learning in literature and in natural sciences by CSCL inquiries. However, the results also reveal failings in students' inquiries, e.g. dominance of superficial approach to inquiry.

Introduction

Computer Supported Collaborative Learning (CSCL) combines learning theoretical approaches that emphasise the meaning of individual knowledge processing and views that highlight the meaning of collaborative discourse in knowledge acquisition (Koschmann, 1996). CSCL seems to be one of the promising innovations to improve teaching and learning with advanced communication technology (Järvelä, Hakkarainen, Lipponen & Lehtinen, 2000). CSCL tools are usually accompanied with inquiry based pedagogical approaches to fulfil the ideas of individual and collaborative settings of learning (Roschelle & Pea, 1999). By participating in inquiries students can reach models from expert working cultures and learn in apprenticeship like manner (Glaser, 1991; Roschelle, 1996). Through inquiries students can improve their understanding of both the content and the scientific practices, which are essential skills for lifelong learning (Hakkarainen, 1998).

There is indication that CSCL can support students' learning cognitively by helping them to structure their activity and to reflect their actions in metalevel (Scardamalia & Bereiter, 1993). CSCL has also potentials in providing tools for organising, representing and visualising knowledge (e.g. Pea, Tinker, Linn, Means, Bransford, Roschelle, Hsi, Brophy, & Songer, 1999; Rochelle & Pea, 1999). Furthermore, by means of technology CSCL applications can offer embedded process supports and multiple resources for student learning (e.g Barron, Swartz, Vye, Moore, Petrosino,

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Zech, Bransford, & CTGV, 1998; Lin, Hmelo, Kinzer & Secules, 1999). In addition to cognitive benefits of CSCL, it is suggested that technology supported social interaction and collaborative learning could lead students to engage themselves in novel forms of knowledge construction (Koschmann, 1996; Dede, 1998). Successful collaboration involves mutual engagement and effort to solve problems together with collaborating participants (Dillenbourg, 1999). Collaborative learning situations afford multiple opportunities for students to create rich representations of problems and apply a variety of problem-solving strategies (Barron, 2000). CSCL can be a powerful tool in creating learning communities where students have a chance to collaboratively make representations, develop explanations of the subject studied and analyse knowledge (Scardamalia & Bereiter, 1993). Above cognitive and social potentials of CSCL, there is also indication of possible benefits to student motivation that it may offer. A study by Järvelä (1996) and Rahikainen, Järvelä & Salovaara (2000) suggest that CSCL might restructure elementary school students' motivational orientation among non-task-oriented students.

There are, however, at leas two caveats in implementation of technology-supported inquiry-based learning. First, there is a need for complementary empirical evidence of benefits of CSCL and inquiry-based activities. Many of the studies conducted in CSCL settings are based on short period of data collection and are implemented outside of real classroom situations. There are only few reports of broader dissemination of these novel practices (Roschelle & Pea, 1999). It is evident that more precise evidence of learning processes that involved in CSCL and inquiry situations is needed. For example, according to Rochelle & Pea (1999) collaborative processes are overemphasized, generalized, and their technology-specific features are not explicated enough. Second, CSCL practices need to be developed concurrently with pedagogical approaches so that technology, classroom activities and learning culture mutually support each other (Edelson, Gordin & Pea, 1999). It should be noted that students may not benefit from CSCL if they are not accustomed in the practices of new learning culture produced by CSCL and inquiry-based activities (Hakkarainen, Järvelä, Lipponen & Lehtinen, 1998).

Aims of the study

This work was motivated by a challenge to experiment CSCL and inquiry-based approach in real classroom situations and gather longitudinal experience in implementing collaborative inquiry culture to classroom. The aim is to examine students' approaches in CSCL-based inquiry process in terms of cognitive and motivational engagement.

Procedures and method

The study was participated by two elementary school classrooms. One of them was lower elementary classroom (n=21) where CSCL and inquiry-based approach was used in natural science lessons. The other was upper elementary classroom (n=18) where CSCL was used in literature lessons. Pedagogical approach in both classrooms was inquiry-based. Topics for learning projects were derived from general curriculum of science and literature. Basically, each class participated on 4-8 weeks learning projects three times. Students had project lessons 2-3 times a week. Teachers supported students' inquiries by instructing them when needed and presenting supporting activities.

CSCL tools, CSILE (Computer Supported Intentional Learning Environment) (Scardamalia & Bereiter, 1994), its' further developed version KnowledgeForum (http://csile.oise.utoronto.ca/) were used to help students to conduct their own investigations and to create forums for social knowledge construction. The environments support students' learning by providing tools for inquiry-based activities, discussion and knowledge production. Basically, they consist of empty hypermedia databases in which the students produce the contents. 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 learning community and all students have equal possibilities to participate to the activity. The applications contain tools for producing, storing, seeking, classifying and linking knowledge by text and graphic processing and discussion tools. Student learning is supported cognitively by helping them to articulate, explore and structure knowledge. Applications also include tools for generating discussion on the topics and possibilities for commenting each other's notes so that students, teachers and experts can collaboratively work with knowledge.

Student learning was examined by gathering data in general level by self-report questionnaires of student motivation, learning strategies and self-regulation. More specific data from CSCL situations consisted of on-line interviews, databases of students' postings and video recordings. The following table (Table 1.) presents an overview of the data collection in both experimental classrooms.

	1st project	2nd project	3rd project
Lower comprehensive school natural science class	- Self-reports - Computer database - Video recordings	- Self-reports - Computer database - Interviews - Video recordings	- Self-reports - Computer database - Interviews - Video recordings
Upper comprehensive school literature class	- Self-reports - Computer database - Interviews	- Self-reports - Computer database - Interviews - Video recordings	- Self-reports - Computer database - Interviews - Video recordings

Table 1. Data collection in experimental classrooms during the project

Student self-reports that included several sub scales were analysed in order to reveal students' general motivational tendencies (Niemivirta, 1996). Following a pattern-oriented approach in studying individual differences in motivation, the students in both studies were grouped by using a K-means cluster analysis into four different groups emphasising different goal orientation, means-ends beliefs and learning strategy use.

Students' actual situational behaviours were examined by database, interviews and video analyses. The content of databases was analysed according to principles of content analysis (Chi, 1997). The categories were based on earlier studies conducted in CSCL settings (e.g. Lipponen & Hakkarainen, 1997; Lipponen, 2000). The videotaped lessons were analysed by drawing a time-line diagram with on-task and off-task dimensions and interaction phases with the teacher and the other students (Rahikainen et al., 1999). This procedure enabled to make a profile of different students' activities as well as to see what were the patterns that formed the whole learning process. Videos were also used to provide authentic case examples of students' situation-specific behaviours during inquiry-based CSCL activities. The interviews were used to provide students' own situation-specific interpretations. Interview transcripts were also analysed by content analyses although the categories were based on motivational and self-regulatory constructs. In the following results are reported by integrating evidence derived from different analyses.

Results – Development of inquiry-based CSCL culture

Students' cognitive approaches in the process of inquiry

The results indicate slight dominance of superficial approach to inquiry especially among the upper elementary school students. Literature class students produced, in all, 367 notes with an average 20.39 (SD = 9.38) notes per student. On the contrary, in the natural science class all students participated to some extent and produced, in all, 662 notes with an average 31.52 (SD = 10.22) notes per a student. The quality of driving question that students phrase in the beginning of inquiry process is crucial to learning (see Hakkarainen, 1998). Particularly in literature class the driving questions that students formulated in the beginning of the learning projects were not complex enough to generate deep inquiries. The results derived from upper elementary school literature class show that 79.6% of the research questions were fact-oriented and only 20.4% of the questions were explanation seeking in nature. Accordingly, information that students wrote to the literature databases in order to provide an answer to research question failed in its purpose in terms of coherency, quality or information value. Only 8.7% of the noted labelled as new knowledge were student-generated explanations that presented a conceptually coherent explanation related to the research question. 91.3% of the inquiry notes included surface-level information. In science class, the quality of the information posted was slightly deeper: 51 % of the questions were explanation oriented. In both classes there were, however, substantial individual differences in the participation rates. In science five students were the most active participants in the class, and wrote 41 to 51 notes, whereas the most non-active participant wrote only 15 notes. In literature most there were only four students who wrote over 30 notes and two most non-active students who wrote only 8 notes. Reasons for uneven participation can be examined by looking students' motivational profiles

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Students motivational approaches in CSCL- based inquiries

The results indicate that students' self-reported preference for certain type of motivational orientation clearly corresponded to their actual engagement in a novel learning environment. This is seen for example in video analyses from lower elementary school biology class. A selection of the videotapes was analysed by drawing a time-line diagram with on-task-off-task dimensions (Rahikainen, 1999). The results show that the learning oriented students' off-tasks periods were minor and they generally involved in progressive knowledge building process. There were two major findings concerning the non-learning oriented students. Firstly, a part of the non-learning oriented students indicated progressive motivation: episodes of high task-involvement and progressive knowledge building processes. However, the other non-learning oriented students created only few meaningful notes and their motivational coping was regressive. The video-data showed that the non-learning oriented students had difficulties to cope with the demands of a knowledge building procedure. However, it was possible to notice that even the extreme cases of non-learning oriented students accepted the working procedures involved in progressive inquiry, even if it was extremely slowly. That is to say that there is minor indication that working with CSCL project may cause qualitative changes in students' motivational interpretations. The novel instructional setting seemed to encourage some students to abandon behavioral patterns that might be expected in basis of their self-reported motivational orientation. There were students who presented clearly different strategic patterns of inquiry and engagement on knowledge construction discussion in different projects. The interview data provides possible explanations for students' context specific motivational coping behaviours. Students expressed factors that may have cause qualitative modifications in their motivational and cognitive approaches in different projects. These were such as task interest, cognitive demands of the environment (e.g. demands for self-regulative actions), and novel cognitive possibilities provided by the CSCL environments (distributed knowledge building processes) and a change of a classroom culture.

The potentials of collaborative knowledge construction discussion

Whereas the student inquiry notes referred to superficial engagement on inquiry the results indicate evident benefits of the collaborative knowledge construction discussion. Almost 69 % of the students' comments were relevant to the inquiry process in science class. In literature class 88.4% of the comments were related to the content of the learning. Students evidently developed practices of commenting each other's work and thereby developed collaborative knowledge building practices. Furthermore, the interviews indicate that students were aware of the possible benefits of collaborative work. The following excerpt presents an example of this.

> INT: Could you please describe how did you work with other students in this project?
> STU: Well, we commented each other's work in CSILE.
> INT: Why was that?
> STU: They provided me some new ideas.
> INT: What kind of ideas?
> STU: Well, for example some suggestions what I could do next.

The analysis of the computer notes collected from the projects showed that there were some unique discussions in databases in which students asked questions from each other and collaboratively created explanations of the phenomena under investigation. The following excerpt from the upper elementary literature class presents an example of students' collaborative knowledge construction activity in the CSILE environment.

> ANNA: Where does time come from?
> ANTTI: It comes from a clock!!!!
> HEIDI Time comes from sun.
> ANTTI: As far as I know sun is not in a clock!!! What do you mead by saying that time comes form sun? It would mean that when the sun explodes the time stops.
> LAURA: How is it possible that the sun would explode?
> ANNA: How does the time come from the sun? Why? Does it not come from a clock? If the time does not come from a clock, where does it come from? How does the time come to the clock? From the sun or from where?
> HEIDI:- People make clocks. Don't ask me how, ask a clockmaker. Let's assume that all the clocks on the earth would be broken. Does the time stop? No.

HEIDI: When the earth goes one time around the sun, it is a year. When the moon goes one time around the earth, it is a month. When the earth rotates once round its axis, it is a day. Do you understand? The time does not come from a clock, time is only measured by a clock.
ANNA: The most common conception is that time comes from a clock. But how does the time come to the clock? From the sun, I was told. Log time ago the calendar was developed and it is still used. I think that the calendar can be explained like this: The earth goes around the sun once and it is a year. The moon goes around the earth once and it is a month. When the earth rotates once around its axis, it is a day. It become clear to me that the exact length of a moon year is 354 3/8 days. It corresponds so called full rotation of the sun from a spring equinox to another spring equinox. The almost recurrence of natural phenomena creates a base for calendar and thereby so-called astronomic chronology is developed. --- But would the time stop or end if the sun would explode. Let's assume that time comes from a clock. If all clocks on the earth would be broken at once, would the time stop? NO. Time can't stop.

Progressive discourse, which comes from science tradition, can be seen as a core of knowledge building (e.g. Chan, Burtis & Bereiter, 1997). This example illustrated how the students participating in this study collaboratively processed an explanation of time, constructed a representation and advanced in explaining the phenomena. Building knowledge requires the students to consciously confront their previous knowledge and the possible misconceptions, and develop more coherent and examined explanations by considering the new evidence presented in the learning situation. Bereiter (2001) sees that scientific progress is not a matter of getting closer to the truth but a matter of improving existing knowledge. As characteristic to progressive discourse, the students mutually advanced in understanding and reflected upon the problem openly. The overall focus of the progressive discourse is on pursuing understanding and on seeing knowledge as problematic and something that needs to be explained.

Conclusions

The results of this study indicate the possibilities of enhancing students learning in literature and in natural sciences by CSCL inquiries. The research is in progress, but it can be stated that students need help in planning and conducting their own CSCL inquiries. Students should be advised to consider the information value and objectivity of the data or information that they use in their inquiries and to construct more coherent explanations to their inquiry questions. It is also evident that inquiry based approaches should be tailored specifically by considering the nature of the subject matter. Inquiry-based learning is generally considered to be an appropriate way of learning science, and it is frequently used in studying physics, chemistry or biology. However, there are not so many studies in which the inquiry-based learning would have been used in teaching social sciences or humanities, such as literature. From a curricular point of view, the challenge seems to be in finding meaningful connections between subject matter specific curriculum and inquiry practices that create possibilities to students to get close to expert working cultures. In next phases of this study it is essential to examine students long-term adaptation to the pedagogical culture of CSCL.

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