THE DESIGN, IMPLEMENTATION, AND EVALUATION OF AN ENVIRONMENTAL-BASED CSCL TASK WITH 5TH AND 6TH GRADERS

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ABSTRACT
The present paper aims to report on the progressive design, development, and evaluation of an environmental-based computer supported collaborative learning task for upper primary school students. In the first section of the paper the significance of appropriate tasks for successful computer-supported collaborative learning is highlighted. In the second section the rationale for the selection of an environmental education task is explained. The method used for the development of the CSCL task is laid out in the third section. The fourth section details the three consecutive, year-long design experiments which were conducted for the refinement the CSCL task. 352 5th and 6th grade students from Greece and Cyprus participated in the experiments in which the authors functioned both as teachers and researchers. The results suggest that the scripting of communication might be more conducive to the quality of electronic discussions compared to the nature of the task employed.

KEYWORDS
Computer-supported collaborative learning, design research, environmental education, task development

INTRODUCTION: COMPUTER SUPPORTED COLLABORATIVE LEARNING

Historically, Computer-Supported Collaborative Learning (CSCL) is the most recent Educational Technology paradigm. Koschmann (1996) notes that CSCL adopts a markedly different approach to learning compared to the former paradigms of Educational Technology in terms of (a) the assumptions about learning and (b) the adoption of new research practices. Compared to the individualistic influences of learning which characterized the former educational technology paradigms, CSCL is heavily influenced by sociocultural theories of learning (Koschmann, 1996). What distinguishes CSCL from other paradigms is the fact that the starting point is learning and the study of how it occurs in the context of social interaction through the aid of technology. In this sense, CSCL is a field of study "*concerned with meaning and the practices of meaning-making in the context of joint activity and the ways in which these practices are mediated through designed artifacts*" (Koschmann, 2002, p. 20). Collaborative learning constitutes the essence of CSCL and this reflects its unique learning epistemology. The principal emphasis is on situated social interaction, communication and collaborative knowledge building. The mediating role of technology is also significant as it can both enhance interaction and facilitate the sharing of knowledge among students.

Empirical CSCL research has yielded very promising results. CSCL environments appear to foster the development of reflective and metacognitive skills (Cohen & Scardamalia, 1998), promote collaborative knowledge building and the improvement of scientific inquiry skills (Hakkarainen, 2003; Hakkarainen & Sintonen, 2002), facilitate complex reasoning (Hoadley & Linn, 2000), and advance the development of distributed design processes (Setamaa et al. 2001; for a comprehensive review see Lehtinen, 2003).

Despite the potential offered by CSCL technologies and the promising results so far, it appears that collaborative learning is not without problems. For example, online discussions appear to be too short, typically involving one initial message followed by two to three responses (Lipponen, Rahikainen, Lallimo & Hakkarainen, 2003; c.f. Guzdial & Turns, 2000), the quality and depth of discussions appear to be rather shallow (Saarenkunnas et al., 2000; Järvelä & Häkkinen, 2002), while an important portion of the discussions is off topic (Lipponen, Rahikainen, Lallimo & Hakkarainen, 1999).

However, considering the history of educational technology, these difficulties come as no surprise. As Lipponen (2000) notes, CSCL technologies in and of themselves cannot change discursive practices in schools. The mere availability of technology is no guarantee that it will be instantly used to change those practices. The fact that CSCL technologies provide affordances for such changes does not mean that those will be exploited. The integration of CSCL in classrooms is not without challenges and, thus, the study of factors inhibiting CSCL success in schools is of utmost importance. Three main types of factors have been identified as affecting CSCL use: technical, organizational, and pedagogical (Lehtinen et al., 1999; cf Bielaczyc, 1999). A significant component related to the pedagogical factor is the activity into which CSCL is integrated.

Traditional classroom tasks and activities are neither compatible with CSCL nor can they be transferred to CSCL -at least not without major adaptation and redesign. Thus, CSCL requires activities which are more compatible with CSCL and would both invite and facilitate collaboration and communication. An important constituent of any activity is the task per se. Research suggests that, even for face to face collaboration, one of the critical determinants of successful collaboration is the nature of the learning task assigned to the students (Arvaja et al., 2000). If a task is too simple and obvious and does not leave space for negotiation, thinking, and creativity, then collaboration might not be facilitated. Collaboration appears to be more challenging when it is technologically mediated, given that computer-mediated communication is more difficult compared to face to face communication. Research indicates that for computer mediated communication the nature of the task assigned is one of the critical success factors (Tolmie & Boyle, 2000; van der Meij & Boersma, 2002; de Vries et al., 2005). As far as CSCL is concerned, the importance of appropriate CSCL tasks has also been stressed. For example, Jarvela et al., (2004) note that one of the most important challenges for instructional design in CSCL is to provide real world tasks and contexts so as to stimulate questioning, explaining and argumentation. To conclude, one of the important requirements for successful CSCL implementation in schools is the development of appropriate tasks.

The objective of this paper is to describe the progressive refinement of an environmental-based CSCL task for elementary students. Three design experiments are reported. The paper details the rationale for the design, development, implementation, evaluation, and refinement of a technology-mediated environmental task. The second section describes the importance of Environmental Education and the rationale for the selection of the task. In the third section the design experiment method which we followed for the development of the CSCL task is presented. In the fourth section the three design experiments conducted are presented in detail. The paper is concluded with a discussion of whether the nature of the task is the most crucial determinant of the quality of communication.

THE TASK: RAISING ENVIRONMENTAL AWARENESS

It is well established in the literature that environmental awareness and attitudes can be significantly enhanced through coordination and collaboration on issues of common concern.

The availability of the internet makes technology mediated communication and coordination on environmental activities more feasible than ever. The global and emerging nature of environmental issues demands radical and collective citizenship action. States and people from different cultures and socio-economic backgrounds face similar problems threatening the quality of their lives. People, groups of people or even nations, can not alone effectively deal with environmental issues. For instance, global

warming, ozone depletion, pollution, and destruction of natural resources are transboundary problems and cannot coped with solitary policies.

Experience has shown that governments, state organizations and authoritative persons, are often inflexible and bureaucratic, preventing the implementation of prompt actions. On the contrary, non-governmental organizations and ordinary people often have the leading role in the environmentally oriented actions. As a consequence, the strengthening and broadening of citizens' participation in the environmental movement is crucial in order to achieve the goal of sustainable development. The role of education in this effort is extremely important and especially in the cases where sound and long-term solutions are needed. Furthermore, the need for cooperation and collaboration not only among people but between official/governmental and non-official/non-governmental parts of the society is also imperative.

DESIGN EXPERIMENT

As there is no established methodology for developing CSCL tasks, we turned to design experiments. The design experiment is one the recent and most promising methodological developments in the learning sciences. Collins et al. (2004) argue that the design experiment fills in a niche which is not covered by other research methodologies. More specifically, the majority of educational research is unrelated to issues and problems of everyday classroom practice and there have been quests for the development of usable knowledge for practitioners. In stark contrast to most research results which cannot be directly applied to practice and owing to its situated nature, the design experiment produces useful results which are both context-sensitive and can be directly applied to practice (Design-Based Research Collective, 2003).

Design research conceives of education as a design or engineering science. Design research was developed as a method to carry out formative research, to test and refine educational designs which are either based on theories or on prior relevant research (Collins et al., 2004). Essentially, a design experiment represents a method for the progressive refinement of an instructional strategy, an artifact, a set of materials, an activity structure etc.

Design research differs from other research methods because of its (a) interventionist and (b) situated nature. Regarding the former, as opposed to other methods, the design experiment is of an interventionist type. The objective of design research is to make an innovation work. In doing so, the researcher is not merely providing materials and instructions for using them in practice; rather the researcher is actively involved in monitoring whether the innovation works and to what extent, suggesting ways of improving what works and dealing with what does not work. Due to its interventionist nature, design research entails the close collaboration between researchers and practitioners, addressing to a certain extent the concerns of both communities. Design research considers the emerging features of the setting in which the design is enacted. An explicit goal of the design experiment is the study of function (Cobb et al., 2003). This study of function entails that it is not only examined which designs work or not but also specific attention is paid to understanding why this happens (Design-Based Research Collective, 2003).

Regarding the latter, design research is different compared to experimental laboratory research or naturalistic participant observation research. The strengths of experimental studies based on laboratory experiments come from random sampling. Nevertheless, many important details often go unnoticed in such designs as the emphasis is on products and not processes (Brown, 1992; Cobb et al., 2003). On the other hand, the strengths of the design experiment stem from its grounding in specific experiences and contexts (Edelson, 2002).

Real learning contexts are more complex than researchers have typically assumed in experimental research. More specifically, educational settings in which innovations are developed should be approached holistically (Design-Based Research Collective, 2003). The design research considers a

setting as a learning ecology (Cobb et al., 2003), that is a situation comprised of several factors: teachers, learners, materials, tools and artifacts, norms, rules, and activity structures. As all these factors are intertwined, the design approach suggests that there is no single independent variable which can make the difference when it comes to innovation. As a matter of fact, in the process of implementing an educational innovation, there are hundreds of decisions which should be made on the spot, for which the theory provides no detailed, how-to guide. These decisions should be made by the teachers who are implementing the innovation. Essentially, the major emphasis of the design experiment is on studying learning in authentic contexts through the systematic design of tools, artifacts, strategies, activity structures, instructional strategies, and institutions.

Due to the fact that it is interventionist, the design approach is iterative in nature: it is implemented in a series of phases (cycles), where the outcomes of each phase are used to inform and shape the design and improvement of the next phase.

The preceding review suggests the appropriateness of the design method for the progressive development of a CSCL task, which by the way has already been stressed in the CSCL literature (Hoadley, 2002; Oshima et al., 2003).

OVERVIEW OF THE PHASES, MEASURES, AND DATA SOURCES

A design experiment approach with three, year-long phases was employed for the purposes of the study. Each phase was implemented as a separate instructional sequence involving a CSCL environmental-based activity. Each phase involved between 30 and 35 class periods of 45' each over the course of the school year (from September to June). The first phase aimed at the development and validation of an ICT-based environmental activity. The second phase involved the adaptation of the activity for CSCL use. Based on the findings of the evaluation of the second phase, the activity was modified and implemented anew in the third phase where the activity was scaled up. In total, 352 5th and 6th grade students participated in the three phases, in which the authors functioned both as researchers and teachers. Since there is no established genre for reporting design experiment studies, we follow the suggestions of Collins et al., (2004), employing a narrative format.

Following the design experiment methodology, we drew on several data sources: participant observations, field notes, student deliverables (letters, reports, surveys, and field studies), the complete record of electronic communication, questionnaires, written reports and evaluations, focus group interviews, whole class discussions, and a detailed log of problems as they surfaced.

1ST PHASE

Rationale of the design

The first phase involved the development and validation of an ICT-based environmental task. What we sought to develop was an authentic, ICT-mediated, environmental-based, collaborative, challenging and meaningful task. Based on findings from the educational psychology, educational technology, and environmental education literature, we devised a task which could meet these criteria. An environmental task was designed to foster the development of ICT skills using a cross-disciplinary approach. The task centered around neighborhood problems and comprised three main components: (a) writing a letter to the city mayor describing the problems of the neighborhood where students lived, (b) conducting a neighborhood survey to determine whether there was consensus regarding the problems identified in the first component and (c) present the letters and the survey results to the city mayor, explaining the problems and requesting specific solutions. A detailed description of the rationale for the development of the task is available elsewhere (Karasavvidis & Malandrakis, 2003).

Setting & Procedures

The first design experiment was implemented by the first author in an urban primary school in the city of Rethimno, Crete. 104 5th and 6th grade elementary students from the 6th elementary school of

Rethimno participated in the study (58 males, 46 females). The majority of the students came from a middle socioeconomic background. The design experiment was conducted in 2001-02 and lasted throughout the school year, occupying a single class period (45') every week. All sessions which involved ICT use were held at the school computer lab.

The task was completed in three major steps. First, a whole class discussion was held where students described problems they were facing in their neighborhood. When several problems were identified and analyzed, students were instructed to write a letter to the city mayor detailing those problems using paper and pencil. Subsequently, the computer lab was used to type and format the letters. Second, the students were introduced to the notion of evidence and the relevant procedures for collecting evidence. They were then guided to develop an instrument and conduct a neighborhood survey asking adults living in their area about the problems they had identified in the first step. Finally, the city mayor was invited to the school and students presented their problems and survey results. The mayor was very pleased with all the hard and insightful (as he put it) work the students had done, confessed that he was very impressed by those young citizens who were very active regarding problems, and discussed these problems with the students. The students asked him several tough questions which he evaded by responding very eloquently.

Outcomes

The task was appropriate for the students. Despite initial conceptual difficulties as to what actually constitutes a "problem", students enthusiastically participated in the task. The fact that an important city official came to the school to listen to what the students had to say about issues within his area of responsibility turned out to be very important for the students. It showed them that they were taken seriously as young citizens by the municipality. Moreover, the school interacted with the community. Coupled with the fact that the meeting with the official received media and press coverage and was discussed extensively in the neighborhood, the students were in the spotlight. This publicity was important as it reinforced the notion that what the students did had some impact in the local context, and attracted attention from other students, parents, and people living in the neighborhood.

The task was very engaging for the students. Initially, they strongly objected to the idea that they were experiencing problems in their neighborhood. They liked the place where they lived and did not understand that there could be "problems". Most of their reactions were of the type “we don't have any problems around here!” However, the area where the school was located and most of the students lived was very near the city center. This meant that (a) there were no playgrounds and children had no option other than playing in the streets or in the pavements and other areas not occupied by cars, (b) there were a few parking spaces available, (c) there was a disproportionately small number of public garbage bins available and (d) there was a lot of traffic which resulted in high noise levels, air pollution, and threats to the safety of children.

The fact that the task was multidimensional entailed that students found some aspects of it more interesting than others (e.g. some students enjoyed more the data collection and analysis procedures while others liked to work at the computer lab and yet others were captivated by the mayor visit). Essentially, the task was both complex and difficult for students. Nevertheless, the task demands did not appear to discourage students. The challenging nature of the task did not turn out to hinder student participation, engagement, interest or satisfaction.

One of most important findings from the 1st design experiment was that students identified themselves with the task, felt responsible for its completion, and essentially came to own it. Levels of engagement were high even among the low ability students. The fact that it involved their own area and problems they continuously faced coupled with the hope that their efforts would eventually lead to the municipality taking appropriate measures, meant that the task was also meaningful to them.

As opposed to most school writing assignments, the letter the students wrote had a real addressee who could actually read it and respond to it. This feature made the task genuinely dialogical. Moreover, the

mayor received a portfolio with all the individual student letters detailing problems and promised to look into them, respond in writing, and provide solutions if possible. Even though the mayor did not eventually respond, he did sent a city street cleaning and garbage/waste collection official to the school a few days after his visit. The official discussed with the students the problem of garbage bins which was the most frequently issue mentioned by students in their letters (in association with the frequency of garbage collection and street cleaning). Students were delighted to see that they had eventually attracted attention. As the city cleaning official promised, a few more public garbage bins were placed in the neighborhood the week after. This fact showed students that their efforts did make a small difference in their local context.

Moreover, in the process of conducting the neighborhood survey, the students interacted with fellow citizens, explained to them what it was they were doing and asked them to participate in the survey (about 83 adults participated in the survey). To a large extent, most of the problems identified by the children were also reported by adults. Understandably enough, playgrounds and sports facilities were high on children's list but not on adults'.

2ND PHASE

Rationale of the design

While the first version of the task did involve student collaboration, this collaboration was mostly face to face within student groups. The goal of the 2nd design experiment was to test the task created in the 1st design experiment for CSCL, i.e. carry out the task collaboratively from a distance. It is known that remote communication and collaboration is difficult for elementary school students. By assigning both groups of students to the same task, it was assumed that a common frame of reference would be created and that communication among students would be supported.

Compared to the 1rst design experiment there were two important changes. First, according to the design, the students should communicate in groups both within and between schools. Considering the pros of asynchronous electronic communication and the fact that it is almost exclusively adopted in the field of CSCL, we decided that the electronic communication would be asynchronous as well. One of the schools involved in the experiment had its own Content Management System (CMS) which was used to host the communication among student groups (Karasavvidis, 2005).

Second, while the surveys conducted in the first phase were conducive to learning, they turned out to be less focused on environmental problems than desired. From an Environmental Education perspective what matters is the elaborate observation and documentation of environmental problems. Thus, we employed field studies instead of surveys in the 2nd design experiment.

All relevant artifacts (letter, surveys, field studies etc) were made available on the school CMS for students to access. This meant that a record of the project could be studied and reflected upon by the collaborating students.

Setting

The 2nd experiment was implemented in two urban schools located in two remote Greek cities, Rethimno and Salonica respectively. The experiment was carried out by the first two authors who were also teachers at the participating schools. Overall, 141 grade 5 and 6 students participated in the study which was conducted in 2002-03 and lasted throughout the year.

As students in the 1st experiment worked in small groups (both in the computer lab and in the course of other activities), this format was maintained for asynchronous communication. Thus, the communication among student groups between the two schools was group-based. Firstly, within each school students were asked to form groups of two to three. Secondly, each student group from the one school was randomly assigned to a student group of the other school, resulting in 37 student group pairs.

The task was identical to the one in the first phase: students in each school wrote a letter to their city mayor describing the environmental problems of their neighborhoods, conducted field studies to collect data and document these environmental problems, and presented the letters and survey results to the city mayor.

Based on the literature, it was expected that an open-ended, multidimensional, authentic task would significantly enable communication among students. Thus, it was deemed appropriate to allow the student groups to communicate only after the first component of the task was completed (i.e. students had identified environmental problems in their area and had written letters to the city mayor). This was deliberately decided so that students would have a common frame of reference upon which all subsequent understanding was to be based.

Outcomes

Students were enthusiastic about communicating with peers from a school far and away and their excitement soared. The realistic nature of communication resulted in an unprecedented eagerness to participate in the project and made the task more captivating. However, several problems surfaced.

First, the students wanted to talk to their peers but preferably not on the topics envisioned by the researchers. The students wanted to talk about other things, such as hobbies, favorite sports, football team, music singer, film star etc. When the children were introduced to the activity, they were informed that they would have the opportunity to communicate with students from another area of the country. It turned out that the children were somewhat hoping that they would have time to discuss issues which were of more direct interest to them, compared to the environmental problems they faced in their areas anyway.

A typical 45' class period appeared to be insufficient for logging into the system, reading the incoming posts, discussing them, determining how to respond and typing in a response. Students raced to achieve this within the allotted time frame which resulted in reduced student satisfaction.

It was assumed that working on the same task would provide a common frame of reference and facilitate the discussions. The systematic analysis of student communication is currently under way. However, preliminary analysis shows that while most student posts were on topic, the overall quality of communication was rather low (Karasavvidis & Malandrakis, 2004). Students realized that they were actually talking past the other groups rather than talking to them. The pattern of communication observed was "*we tell you our problems you tell us yours*". For most students, this was the first time that they communicated asynchronously and were not actually prepared for the difficulties of such a communication type. The initial enthusiastic response to communication was followed by dismay, disappointment, and even anger.

Overall, students wrote letters, conducted field studies on environmental problems, were enthusiastic about the mayor visit and kept hoping that their problems would be solved by city officials. However, despite our continuous interventions, the communication among students groups was of poor quality. What is more, students expressed clear dissatisfaction with the communication and at times lack of motivation to continue. Thus, even though it was assumed that parallel work on the same task would facilitate the creation of a common frame of reference thereby enabling quality discussions, this was not the case. Very few student groups expressed contentment with how the electronic communication with their collaborators went. Thus, a common task did not appear to be conducive to the quality of communication.

3RD PHASE

Rationale of the design

Since parallel work on the same task resulted in suboptimal dialogue quality and did not positively influence the quality of communication, in the 3rd design experiment we focused on scripting the communication in an attempt to consider its influence on the quality of the discussions. As the students from the participating schools did not have a common frame of reference (since not all of them were engaged in the same environmental task) communication had to be redesigned to be meaningful. Based on the findings of the second design experiment, we paid explicit attention to the structuring of communication and took three main measures.

Firstly, several communication examples were provided (e.g. a telegram does convey a basic message but there is lot missing as to why or how). Students were provided with explicit instructions and guidance prior to communicating. It was explained that there was a possibility that the responses from the collaborating groups might be difficult to understand. As the complete record of communication was available on-line, the students were asked to read several threads and comment on whether they were comprehensible or not. This afforded a great opportunity for discussion and reflection. Most of the student groups reported that they could hardly make sense of the threads and, thus, something went noticeably wrong with the communication. Students were able to determine the two major sources of error in the electronic communication of the 2nd experiment: messages were (a) brief and (b) cryptic. As a result of this preparatory discussion, the students came to realize that in addition to being fun electronic communication might also be challenging.

Secondly, students were provided with three rules of thumb to handle communication problems. First, they were instructed to read the whole thread carefully and not just focus on the last post. In the 2nd experiment it was observed that students tended to focus on the last post, ignoring the rest of the thread. Ironically enough, some student groups had a hard time interpreting a post, only to turn out upon closer inspection and help by the teacher that what they had gotten was an answer to a question that they themselves had posed in the first place! Second, the students were instructed to write as elaborate messages as possible so as to avoid being read as cryptic by their collaborators. Third, students were uniformly instructed to pose questions to their collaborators in case of failing to understand what the message meant as opposed to asking the teacher. A recurrent pattern in the 2nd design experiment was that the students kept asking the teachers what a post meant. Of course, it was impossible for the teachers to know what a group of students a few hundred miles away really meant by what they had written. At times, it was even difficult for the students who had written the message a week before to provide a clear explanation of what exactly they meant or what they were thinking.

Finally, the communication was divided into three distinct phases. In the first phase, students exchanged information about the problems they experienced in their neighborhoods. In the second phase, they were asked to find relations between local and remote conditions (i.e. problems). In the third phase they were asked to suggest solutions to the collaborating partners, based on knowledge of successful solutions to similar problems in their local contexts.

In addition to scripting the communication, several other problems which had surfaced in the realization of the second design experiment were taken into consideration. For example, logging into the system turned out to be a bigger challenge than anticipated. Initially, group accounts were created for use on the school portal so that student groups could access the forum and post messages. However, the groups tended to pick "cool" passwords which unfortunately they tended to forget, resulting in considerable delays as the passwords had to be reset. In the 3rd design experiment, the first author selected the passwords which were based on the usernames and were easy to remember.

Setting

109 5th and 6th grade students (62 males, 47 females) from two Greek schools and one Greek-Cypriot school participated in the study (62 students from the 6th primary school of Rethimon, Crete, 27

students from the 3rd primary school of Aigaleo (suburb in Athens metropolitan area), and 20 students from the Germasogia primary school of (Limassol, Cyprus)). The design experiment for this phase was conducted in 2003-04 and lasted throughout the school year.

The first author taught in the school of Rethimno (Crete), the third in Limassol (Cyprus), and the fourth in Aigaleo (Athens). While the students in the 6th primary school of Rethimno participated in the complete environmental task developed in phase 1, the students from the other two schools were simply introduced to electronic communication using the procedures described above.

Outcomes

Interestingly enough, even though the students lacked a common frame of reference, the scripting of communication did appear to facilitate discussions. In fact, noticeable improvements emerged in the quality of communication compared to the 2nd design experiment. Nevertheless, the overall quality of communication was below expectations, resembling more a friendly chat than an in-depth discussion.

CONCLUSIONS

The study reported in this paper is different compared to other CSCL studies in three important respects. First, students collaborated over distance as opposed to working in groups within a classroom, which is typical of most CSCL studies. Within classroom CSCL appears to be more manageable for students owing to the shared knowledge of task and context. Second, we employed a design experiment approach which, even though gaining momentum for CSCL studies, is not yet typical in the field. Third, students did not have to collaborate to create a common product (i.e. artifact, report, etc). The task we developed involved student communication over distance but not collaboration per se, as the main goal was to raise environmental awareness. While the emphasis in the 3rd design experiment was on the exchange of information and on understanding the perspectives of the collaborating groups, in the 2nd design experiment the emphasis was on communication in order to undertake and coordinate environmental action.

Even though data analysis is not completed, preliminary results from the 3rd design experiment show that the creation of a common frame of reference by using the same task does not appear to be as decisive for the quality of communication as the scripting of the communication. It could be the case that when an open-ended, authentic, and meaningful task is used for CSCL, then the quality of the interaction is more likely to be affected by other factors, such as the structuring and the scripting of communication. This tentative conclusion seems to be supported by other research, e.g. de Vries (2004; cf. de Vries et al., 2005) found that the scripting of interaction through the use of various scaffolds did result in improved communication between students exchanging emails.

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