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Collaborative Technology for Facilitating Progressive Inquiry: Future Learning Environment Tools

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Abstract: The design of a web-based, networked learning environment, Future Learning Environment Tools (FLE-Tools) embodies a model of progressive inquiry. In this paper, we introduce the progressive inquiry model and describe how different modules FLE-Tools are designed to facilitate participation in this kind of inquiry. Results of a pilot experiment of using FLE-Tools in higher education are presented. The study was based on an analysis of 125 messages posted by thirteen university students to the FLE-Tools database. The results indicated that the course provided positive evidence for an integration of progressive inquiry and online discussion. The pedagogical and design challenges with which we are currently struggling are discussed: the problems of creating a learning community for students collaborating at distance or managing large number of entries in FLE's database.

Keywords: inquiry, groupware, scaffolding, higher education

Introduction

A fundamental aspect of the design of computer supported collaborative learning (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 (Scardamalia & Bereiter, 1993; 1994). Progressive discourse occurs, for instance, in the sciences demonstarting both accumulation and deepening of knowledge. Through these kinds of collaborative learning tools, the users are able to rely on the socially distributed resources of the learning community in conducting their study projects (e.g., Salomon, 1993; Pea, 1994). A central principle of designing collaborative technology is to provide structures and activities that foster monitoring of one's own and the other students' comprehension and reflect advancement of inquiry (Bereiter & Scardamalia, 1993; Brown & Campione, 1996).

The present study describes the cognitive-design rationale of a new-generation, networked learning environment, called the Future Learning Environment (FLE-Tools) developed by the Media Laboratory, University of Art and Design, Helsinki, and the Department of Psychology, University of Helsinki. The environment is a groupware system designed for supporting collaborative knowledge building. The primary users of FLE-Tools are university students and people in in-service training at various organizations. The users are able to access it from any internet-linked computer and post ideas and thoughts to FLE-Tools database directly or using their standard office applications and productivity tools. The “knowledge” posted may be in various formats, such as text, graphics or video. In this paper, the pedagogical model of "progressive inquiry" embedded in the FLE design is discussed; to demonstrate the use of FLE-Tools software, results from a pilot experiment of using FLE-Tools in a university course will be presented.

Model of Progressive Inquiry

In the present study, the sustained processes of advancing and building of knowledge characteristic to scientific inquiry are called *progressive inquiry*. The model of progressive inquiry (PI-Model) relies on recent advancement in cognitive research on educational practices and equally, on a dynamic and pragmatic conception of inquiry emerging from the philosophy of science (Hakkarainen & Sintonen, 1999). The former approach emphasizes the importance of engaging students in processes of question- and explanation-driven inquiry by imitating practices of scientific research communities. Progressive inquiry entails that new knowledge is not simply assimilated but constructed through solving problems of explanation and understanding (Bereiter & Scardamalia, 1993). The latter focuses on conceptualizing processes and strategies of creating new knowledge, not just representing accomplished results. Shared knowledge advancement requires that students engage in a systematic effort to advance shared knowledge objects, i.e., hypotheses, theories, explanations or interpretations (Scardamalia & Bereiter, 1996). Both of these approaches acknowledge the socially shared character of inquiry. In the following, a conceptual framework of progressive inquiry (Figure 1) is outlined and each aspect of inquiry briefly discussed.

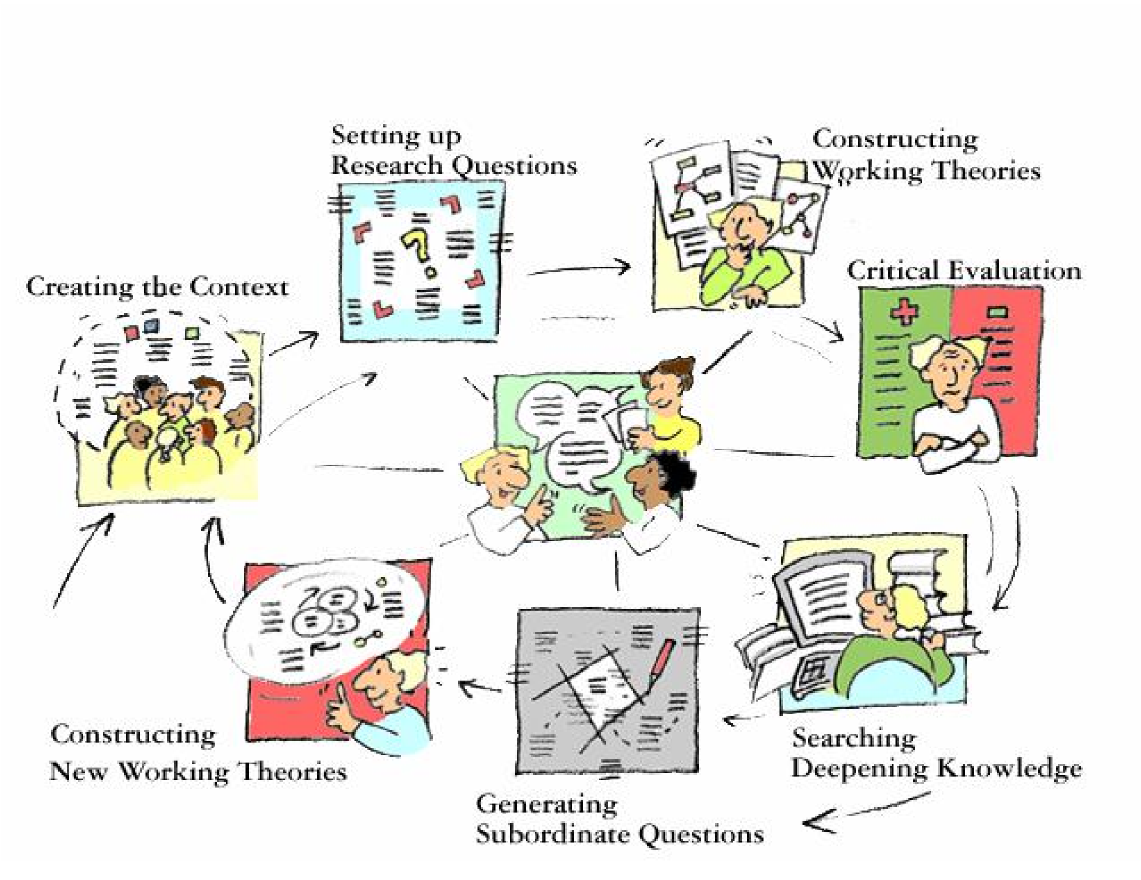

Figure 1. Elements of progressive inquiry

Creating context

A starting point of the process of inquiry is creating a context for a study project in order to anchor the chosen issues to central conceptual principles of the domain of knowledge in question or to complex real-world problems addressed by experts (Cognition and Technology Group at Vanderbilt, 1997). The purpose of context creating is to help the students to understand why the issues in question are worthwhile to investigate and to cognitively commit to solve these problems. Instructor or tutor has a very important role in creating the context jointly with the students; essentially, he or she needs to guide the learning community to jointly plan and set up goals for a study project.

Engaging in question-driven inquiry

An essential aspect of progressive inquiry is to set up questions or problems that guide the process of inquiry. Scientific inquiry can be seen as a problem-solving process: initial question define the domains where the inquiry is directed and more refined questions guide the porcess. However, university students are frequently conducting their studies without any such guiding questions. Conceptual problems that arise from students' own attempts to understand and explain the problems being investigated, have a special cognitive value in the process of inquiry, helping a student to guide and regulate their knowledge-building efforts.

Generating one's own working theories

Another important aspect of inquiry, and a critical condition of developing conceptual understanding, is generation of one's own *working theories* – one's conjectures, hypotheses, theories or interpretations – for the phenomena being investigated (Carey & Smith, 1995; Perkins, Crismond, Simmons, & Under, 1995; Scardamalia & Bereiter, 1993). Construction of working theories guides students to systematically use their background knowledge and make abductive inferences to explain new phenomena and extend understanding. Progressive inquiry aims at facilitating explication and externalization of a student's intuitive conceptions, through guiding students, for instance, to write about their ideas. Further, it is intended to make the differences between one's own conceptions and scientific conceptions more salient and accessible to the student. This, in turn, is likely to facilitate conceptual restructuring.

Critical evaluation of knowledge advancement

Critical evaluation addresses the need to assess advancement in knowledge-seeking inquiry in a constructive way. Through evaluating whether and how well the working theories explain the chosen problems, the learning community seeks to assess strengths and the weaknesses of different explanations and identify contradictory explanations, gaps of knowledge, and limitations of the power of intuitive explanation. The evaluation helps the community to direct and regulate joint cognitive efforts toward searching new information that will help advance shared understanding.

Searching new scientific information

The questions generated and working theories constructed provide heuristical guidance in the search for new scientific information by suggesting possible directions in which potential answers and more specific information can be sought. By examining one's prior problem statements or working theories with the help of new information, the student may become aware of his or her inadequate presuppositions or background assumptions. Further, large bodies of information cannot be managed without questions that guide and constrain the knowledge seeking process and help to conceptually structure obtained information. The question-guided search for new scientific information is likely to facilitate transition from reference to problem-centered knowledge, and, therefore, elicit conceptual restructuring (Bereiter, 1992).

Engagement in deepening inquiry

In genuine problem-solving situations one has to start to generate questions and tentative theories before all necessary information is available. As a consequence, the process of inquiry often has to start with very general, unspecified and "fuzzy" questions and tentative working theories (Sintonen, 1991). In spite of gaps, weaknesses, or unclarities, these kinds of general questions and working theories function as tools of inquiry and provide a basis for progressive inquiry. A critical condition for progress is that a student focuses on improving his or her theory by generating more specific questions and searching for new information. The process of inquiry advances through transforming and refining the initial big and unspecified questions into more specific questions following the interrogative model of inquiry (Hintikka, 1982; Sintonen, 1984). The dynamic nature of inquiry is based on the generation of intuitive explanations and acquiring of new scientific information, which in turn make new research questions and more elaborate working theories accessible to the students, theories that could not have been anticipated in the beginning of the inquiry. Through generating new questions, searching repeatedly for new information and constructing more and more articulated working theories, a student moves step by step toward answering the initial big question.

Shared expertise

All aspects of inquiry – such setting up research questions, searching for new scientific information, constructing of one's own working theories or assessing the explanations generated – can be shared with fellow inquirers. Cognitive research indicates that advancement of inquiry can be substantially elicited by relying on socially distributed cognitive resources, and collaborative efforts to advance shared understanding. There is, further, a growing body of evidence that cognitive diversity and variation in the fields of expertise promote knowledge advancement and cognitive growth. Through social interaction, contradictions, inconsistencies and limitations of a student's explanations may become salient to him or her; one is forced to perceive conceptualizations from different points of view. Collaborative inquiry facilitates deepening conceptual understanding by pushing a student to commit to some idea or belief, as well as to organize and reorganize his or her knowledge (Hatano & Inagaki, 1992).

Description of the Design of FLE

General design of the environment

The Future Learning Environment (FLE) is based on a three-tier architecture in which the FLE-Tools software is distributed among three servers: The database server, where most of the changing information (the database and search engine) resides, the application server that handles most of the logic in conjunction with the database server, and the www server that handles the backend www-processing and glues the other servers together. FLE software can be accessed through Internet (TCP/IP) with any HTML 3.2 compliant browser such as Netscape Navigator 3 (or later). Some non-critical features can only be accessed by browsers with a JavaScript implementation. The users are able to work with common office applications or productivity tools producing, for example, documents, graphics, video or www links. The

Internet accessibility allows small groups working at different locations to coordinate their activities with the tools provided by FLE. The main modules of the FLE-Tools that will be described include the Virtual WebTop, the Kwoledge Building Module, the Jam Session Module and the Library.

Virtual WebTop

The Virtual WebTop refers to a personal adjustable display window, which is automatically opened as the user logs onto the system. The Virtual WebTop contains graphical links, represented by folders, that give information about the course attended, links to the Virtual WebTops of the other participants of the group. The Virtual WebTop is a place for the user to store his or her documents created by standard office applications in various formats. It is the main center for the user's own knowledge production, and may contain large documents such as research proposals, term papers, designs, or project reports that are related to one or more FLE projects.

The Virtual WebTop also has a search engine built in, enabling search into materials previously produced in other courses and also all materials in the Library. In the background of the Virtual WebTop is a metaphor of an open office in which you could go to work in any desk, observe what other people are working on, and leave your own notes. Accordingly, the Virtual WebTop allows a student to visit in WebTops of other users in the same course. Through examining fellow students' Virtual WebTops, students are able to share the process of inquiry and to get acquainted to their fellow students' interests, and to observe their studies across different courses. Coordination of collaborative inquiry efforts is supported by a tool that allows a students or tutor to leave messages to other participants Virtual WebTop as well as review messages received and sent.

The Knowledge Building Module

The Knowledge Building (KB) Module provides a shared space for working together for solving problems and developing ideas and thoughts generated by the users. All KB messages within a course are posted to the shared space, visible as lists of messages. Each KB discussion is accessible only to the users enlisted as participants of that specific course.

Participation in progressive inquiry is facilitated by asking a user who is preparing a discussion message to categorize the message by choosing a "category of inquiry scaffold" (e.g., Problem, Working theory, Summary) corresponding to the PI-Model (based on the practices of Scardamalia & Bereiter, 1993). These scaffolds are designed to encourage students to engage in expert-like processing of knowledge; they help to move beyond simple question-answer discussion and elicit practices of progressive inquiry.

The Jam Session module

In contrast to the KB Module, the Jam Session encourages free flow of ideas and experimentation with different ways of representing knowledge. The environment provides tools for storing different versions of the object being developed, whether it be a design, a project report or some other type of document. The users may take a version of the object and elaborate it further, and save it for the other users to be further develop. The Jam Session module assists in making thinking visible (Brown, Collins, & Duquid, 1989; Scardamalia & Bereiter, 1989) by providing a graphic representation of development of a knowledge object.

The Library

The Library allows the users to share the documents produced in various formats: text, graphics, audio, video, multimedia, or www links. The Library contains course materials chosen by the tutor as well as materials produced by the users. Materials from earlier courses may also be stored in the Library and made accessible to later users. The environment is intended to provide tools for helping teachers and students to create digitized study materials, to collect interesting link addresses to folders, and also gain access to other libraries linked to the internet.

Research Method

Research questions and participants

The purpose of the present study is to report results of a pilot experiment of the FLE-Tools at university-level education. The pilot experiment took place very soon after we established the first working pilot version of the program, and only the KB module was tested. Nevertheless, the pilot course provided essential information concerning cognitive-design challenges of FLE-Tools as well as guidance for further development of the learning environment. The study, in sum, primarily investigated whether and how the FLE-Tools facilitates participation in progressive inquiry. Specific problems addressed included the following: 1) What is the nature of KB messages produced by the participants? 2) How does the KB represent the model of progressive inquiry? 3) How did the students used the scaffolds provided by the FLE-Tools?

The data were collected from a nine-week course on “Perspectives of cognitive psychology on media education” at the University of Helsinki. The study group consisted of thirteen marter’s gedree students of media education. The group had weekly face-to-face seminar meetings, and their course credit was obtained from reading the study materials, and actively participating in the seminar sessions and KB discussion in FLE’s database.

During the nine-week course the students posted 125 messages. In addition, the instructor posted 9 messages to FLE’s database. These latter messages represented the principal research problems of the course, constructed collaboratively by the study group. Each question opened one knowledge-buiding thread, e.g., “How does the new information and communication technology support development of students’ expertise in different contexts?” or “What kind of new pedagogical problems may emerge in networked learning environments?” The students themselves were allowed to decide which particular problems they would pursue. Apart from these messages that helped to conceptually organize the study group’s FLE work, the instructor did not take part in the discussion being posted to the database.

Data analysis

The postings to the database KB Module constitute the data analyzed in this study. The database material was analyzed with qualitative and quantitative methods in order to evaluate the process of knowledge advancement. The methods applied to analyzing the date aim at providing a richer view on the content and the progression of the discussion (see Chi, 1997).

The KB module of FLE-Tools has seven built-in scaffolds and a student had to choose one of them to describe the message before it was posted to the database. The following categories of inquiry scaffolds were also used to analyze how the students categorized their messages: Problem, Working theory, Deepening knowledge, Comment, Metacomment, and Summary (Help has been left out of the analysis because it was not used by the students). An examination of the students' productions indicated that their messages in fact consisted of several ideas. Therefore, the messages were further segmented into propositions, which were considered to address only one aspect of inquiry. To analyze the reliability of segmentation, an independent coder classified approximately 15 percent of the messages. The inter-coder reliability was .91, indicating that the reliability of segmentation was satisfactory.

To explore the nature of knowledge presented in the messages, each segment or idea was classified according to five principal "*idea categories*" identified in the coding process: Problem, Working theory, Scientific explanation, Metacomment, and Quote of another student's idea. All of the propositions fitted in these five categories of ideas, which were regarded to be mutually exclusive. Further, to analyze the reliability of classification, an independent coder classified about 20 % of ideas; the reliability coefficient was .86, which was concidered satisfactory. In the following, each category of ideas classified is described and transcriptions of corresponding student productions are presented.

The Problem category refers to all the question produced by the students and also the collaboratively produced problems entered by the instructor. We were specifically interested in cases where a problem was formulated as to be, in fact, a progressive-inquiry question, i.e., a question unanswerable with students' prior knowledge which would initiate a search for explanation (Hakkarainen, 1999).

> *Does the role of guidance change as one enters into a virtual learning environment (which could be of multiple types)?* (student 5, 1st quarter, in a message labeled as a comment)

> *Is the role of co-learner especially emphasized in the framework of progressive inquiry?* (student 9, 1st quarter, in comment)

The category of Working theory represented students' own ideas and thoughts, their own explanations for the problem being investigated or generalizations of their experiences.

> *There exists knowledge that can be described as authority knowledge. It seems paradoxical that in our modern era of unlimited flow of information, we need, in an increasing amount, to believe in what domain authorities or experts say.* (student 12, 3rd quarter, in deepening knowledge)

> *On the other hand, new tools acquire their meaning in the hands of the users and "evolution" must roam still for a while before the most essential tools will surface and we no longer need to concentrate so much on the mastery of a tool.* (student 1, 1st quarter, in comment)

Scientific explanations category represented the explanations that contained explicit reference to an article, book or other study material that the student had read and based the explanation on. While working theories contained an explicit reference to a student's own ideas, scientific explanation represented information presented in study material or some other expert sources. Usually the students explicitly mentioned the source of information used.

> *Hakkarainen and Jarvela wrote that expertise refers to well-organized and usable knowledge structures combined with unusual ability and skill to solve complex problems.* (student 4, 3rd quarter, in deepening knowledge)

> *The problems that student 4 has mentioned are also stated in the SITRA report. The teachers wanted to have more pedagogical training for use [of ICT]. And just those teachers, who would seem to have the most potential for developing meaningful ways to use computers, usually end up sacrificing their energy to maintaining the equipment.* (student 3, 3rd quarter, in comment)

Metacomments consisted of assessments of one's own learning, advancement of the discourse or functionality of the FLE-Tools. Ideas were regarded to be metacognitive when they contained an explicit expression of a generalization from one's own or the group's experience, an evaluation of one's own thinking process (e.g., confusion) or a reflection on the learning process.

> *On the other hand, to function as a collaborative environment, presenting and solving problems, and creating new knowledge, we ought to pay more attention to collaborative problem setting than what has happened so far*. (student 9, 1st quarter, in comment)

A student was said to quote another student's idea if he or she presented excerpts of that student's earlier messages within the one currently being posted. A quote contained the verbalizations of someone other than the author of the analyzed massage. Therefore, it contained ideas the author had chosen to highlight from previous discussion.

Results

The amount of messages posted in the four quarters were 53 messages during the first quarter and 24, 23, and 25 messages on the following quarters respectively. The quarters are based on time scale, approximately 2.5 weeks each. The lowest number of messages posted by one student was 1, while the highest was 32. The average amount of messages posted by students was 9.6 ($\underline{SD}$ = 8.0). The students were working in the FLE according to their own schedules, records indicated that work took place mostly during afternoon and evening hours. The messages were on average 92 words long in the Finnish language ($\underline{SD}$ = 13.2).

The use of category of inquiry scaffolds (messages)

The analysis concerning how the students categorized their messages by using the built-in scaffolds (i.e., Problem, Working theory, Deepening knowledge, Comment, Metacomment, and Summary) indicated that the relative proportion of messages representing Comments was rather high, 62.4 % (n = 78). The frequencies of other categories of inquiry scaffolds were lower: Problems 11.2 % (14), Working theories 3.2 % (n = 4), Deepening knowledge 7.2 % (n = 9), Metacomments 3.2 % (n = 4) and Summaries 12.8 % (n = 16). This arguably reflected the tendency to choose a scaffold label that was perceived as neutral or responding to an earlier message. The selection of an appropriate scaffold was also a topic in the database discussion, as one student explains in a message labeled Problem (in parenthesis is the "category of idea" each idea within the message was assigned in the analysis):

> *"The choice between the Categories of Inquiry is puzzling: what does it mean, and more importantly, how possible is it to separate them during a practical task* (problem)*? A comment may contain equally much information as deepening knowledge* type (working theory). *Or is it a problem because I'm not used to this new environment* (problem)?" (student 9, 1st quarter)

Despite the obvious uncertainties the students had about using the scaffolds, the scaffolds appear to have helped students reach at least some of the cognitive goals set forth. This student, as well as others, was deliberating on her understanding and the ways to present knowledge in the discussion.

We further investigated the distribution of ideas within messages. The mean number of ideas in a message was 4.50 (SD = 2.57). The number of messages, ideas and mean number of ideas in a message for each student is displayed in Table 1.

Table 1. Number of messages and ideas produced by students.

Student	Messages	Ideas	Mean number of ideas in message	SD
1	5	22	4.40	3.7
2	13	55	4.23	3.0
3	7	32	4.57	3.3
4	12	58	4.83	3.0
5	6	40	6.67	2.6
6	1	4	4.00	
7	9	50	5.56	2.5
8	8	29	3.63	2.3
9	32	127	3.97	2.0
10	4	27	6.75	3.8
11	14	45	3.21	2.4
12	13	69	5.31	1.9
13	1	4	4.00	
Total	125	562	4.50	2.57

Nature of ideas produced (ideas within messages)

The students took most active part in the discussion during the first and the last quarter of the course, producing, during that time, 67 percent of all ideas. The analysis of the proportions of ideas generated indicated that 25.5 % (n = 126) of ideas were Problems, 38.8 % (n = 192) were explanations in form of Working theories, Scientific explanations were 6.2 % (n = 31), Metacomments were 13.3 % (n = 66), and 16.2 % (n = 80) were Quotes of other student's ideas. The distribution of the different categories of ideas is presented in Figure 1.

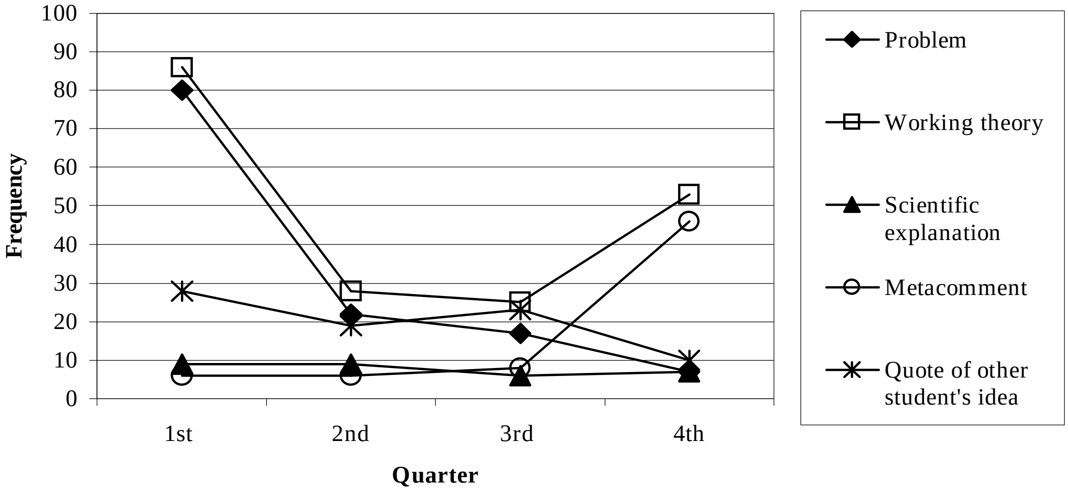

Figure 1. Frequencies of different categories of inquiry ideas produced.

The results indicated that the frequency of problems was the highest during the first quarter of the discussion and gradually decreased, apparently indicating the construction of initial research questions in accord with the model of progressive inquiry. However, a second peak expected from developing deepening problems is less evident, although the data revealed that the participants produced a reasonable number of questions throughout the course (during the 1st quarter 80, and 22, 17, and 7 on the following quarters respectively).

The amount of ideas representing working theories was highest during the first and the last quarter. By contrast, the category of scientific explanations remained at a strikingly low level throughout the course. Apparently, the students did not engage in an intensive search of new information during the database discussion. However, one reoccurring point of evaluation posted by the students to the database during the last quarter was the observation of the low number of scientific explanations compared to their own intuitive explanations. These comments suggest that the students may have understood the value of deepening scientific explanations in the process of progressive inquiry, even though they did not change their own practices accordingly during this relatively short course.

The results analysis indicated that the students were building new ideas on knowledge produced by their fellow students, and thereby, the database was considered to show remarkable connectedness (Hewitt, 1996). This is indicated by the fact that quotes of other student's ideas showed a steady level during the first three quarters and decreased only during the last quarter. An interesting discussion culture was developed, which used quotes from previous messages to set a context for new entries. It is important that the students very selectively maintained only the parts of a prior massage that they were elaborating on. The design of FLE also supports this contextualization process by including the original message being answered, in the writing field of the new message.

The frequency of statements that were regarded as representing metacomments increased as the course proceeded, particularly during the last quarter, likely influenced by explicit instructions from the tutor to summarize one's own learning. The data indicated that the students showed explicit metacognitive efforts to evaluate the advancement of their knowledge and reflected on how their own practices of studying and writing could be improved.

Conclusions

FLE-Tools environment was used in a pilot course to facilitate progressive inquiry in university education. A model of progressive inquiry was introduced to a master's degree course of educational technology. The analysis of discussion held within the FLE-Tools database with 13 participants found evidence that the learning environment provided support for progressive inquiry, by making it possible. Instead of keeping only their own learning logs, the students shared their process of inquiry and participated in intensive discussion about the topics in question. The number of questions produced was the highest during the first two quarters of course. The amount of students'own knowledge expressed in form of explanations remained relatively high. The proportion of metacognitive evaluations showed an encouraging increase as the weeks passed. In addition, the students were referencing each other's ideas in the discussion, and developing them further. The pilot testing revealed several issues that should be addressed in further developing FLE-Tools environment and using CSCL in university-level education.

Scaffolding Challenge

The students were asked to categorize their posting to the database by using a set of cognitive scaffolds. However, the content analysis indicated that the students' productions often did not correspond with the scaffold they chose. The students showed a bias for selecting a Category of Inquiry that was very neutral, mostly Comment. Furthermore, their productions represented several categories, such as problems, working theories and deepening scientific explanations, simultaneously.

There appeared be two reasons behind this phenomenon. First, although the students were introduced the PI-Model, they did not have an opportunity to practices the use of scaffolds, for instance, in joint sessions of using FLE. A thematic analysis of the discussion suggested that a tutor's "just-in-time" participation could have significantly changed this pattern, judging from the evaluations and reflections of the students. An implication for further courses is that the participation of a tutor into the discussion is recommended, at least for course with new users, until a pattern of interaction is established which explores all scaffolds provided by the environment. Second, it is possible that it is not natural for the students to partition their posting in a way that corresponds to the given scaffolds; the students wrote rather long entries (often half a page) in which they set up as well as explained their problems. As a consequence, it would be important to further develop the functioning and the types of scaffolds by allowing, for instance, categorization within a message.

Tutoring Challenge

The tutor of the course did not participate in the database discussion during the course. The feedback from the course together with the thematic analysis would seem to suggest that in order to successfully engage in a deepening inquiry, the students would need the tutors' support. This problem has been successfully solved in some other courses by engaging another supporting tutor to a course. Further, it would be important to provide the learning environment with tools that would allow the tutor to print all productions simultaneously. We are working to create Tutor's Tools that would provide a summary of discussion and each student's contribution during a course, and thereby help the tutor to get an overview about what is going on in the database during the process.

Knowledge-Management Challenge

An examination of the database indicated that there was a substantial knowledge-management problem. A relatively large number of messages makes it difficult to follow the discussion and get on overview about issues being discussed (see for discussion Goldman, 1996). The fact that discussion was organized around a set of principal problems provided significant help, but an intensive discussion – possibly ten or more steps deep – was time and effort consuming to follow. Indeed, the participants, who joined the discussion the latest, reported that it was difficult to participate in the discussion without being closely involved from the very beginning, partly due to the large amount of messages to be studied before making a new contribution. In order to lessen this problem, it is necessary to develop tools that would help to organize the messages. We are currently working with an application of methods of neural networks to organize the discussion by relying on dynamic HTML and JavaScript implementations.

In-depth Inquiry Challenge

Experiences of the course suggested that the students were relying very much on information provided by the tutor rather than being engaged themselves in deepening inquiry. The information obtained from books, articles, and study materials introduced as course material played a minor role in the explanations produced by the students. This may reflect a larger curriculum design problem: Students are simultaneously engaged in a number of small courses rather than pursuing a few courses in depth. As a consequence, they are not used to carrying out intensive independent research for deepening knowledge in their courses, but rely on a few key articles or study materials. In order to facilitate progressive inquiry, it may be necessary to change the structure of study programs and focus on a smaller number of in-depth courses in which students would be required to engage in their own inquiry.

Challenge of Community Building

An examination of the relative proportion of ideas representing different categories of inquiry suggests, however, that substantial pedagogical support may be needed to elicit in-depth inquiry. There were considerable differences among students in intensity of their participation. In order to introduce students to the model of progressive inquiry, it is important to have joint sessions of working with FLE-Tools, not just a seminar and individual participation at distance. Further, to intensively participate in virtual learning environments, the students apparently need strong community support that would induce them to participate and guide them in doing so. Joint working with the environment would help the students to adopt the progressive inquiry model, learn to use FLE-Tools effectively, and jointly develop good practices of working with FLE.

Overall, the explanations produced by the students did provide valuable shared knowledge on how the students perceived working with an online environment and the opportunities they saw for its use in education. Together with externalization of their own knowledge and the increase of metacognitive evaluations produced by the students, the course and the investigation revealed evidence suggestive of the possible benefits of integration of progressive inquiry and online discussion as a complement to face-to-face seminars.

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