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Teachers' instructional planning for computer-supported collaborative learning: Macro-scripts as a pedagogical method to facilitate collaborative learning

Raija Hämäläinen*, Päivi Häkkinen

Finnish Institute for Educational Research, University of Jyväskylä, Finland

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ABSTRACT

Technological tools challenge teachers' pedagogical activities. The use of information and communication technologies (ICT) in education should help teachers integrate new pedagogical methods into their work. This study explores macro-level computer-supported collaborative learning scripts as a pedagogical method to facilitate collaboration. Macro-scripts set up conditions in which favourable collaborative activities such as argumentation should occur. This case-study examines the difference between the "ideal" script and the "actual, realized" script to find out how collaboration differs between different groups. This study demonstrates that macro-scripts support collaboration by introducing the reason for interaction and by helping students solve learning tasks. However, macro-scripts do not guarantee high-level collaboration.

1. Introduction

According to Laurillard, Oliver, Wasson, and Hoppe (2009), technology-enhanced learning (TEL) should link educational aims, relationships between practice and innovations, and the authentic needs of the local context. New technological tools challenge teachers' pedagogical activities and professional development (Arvaja, Hämäläinen, & Rasku-Puttonen, 2009). At their best, technological applications offer tools to support collaboration within teams (e.g., Koschmann, 1996). As technologies themselves are rarely designed with collaborative learning and teaching in mind (Laurillard, 2009), there are several challenges in orchestrating TEL (see Dillenbourg, Järvelä, & Fisher, 2009). In a collaborative learning environment, teachers are expected to support, structure, and coach students, instead of transmitting knowledge to them (Volman, 2005). Therefore, emerging concerns of current research include teachers' instructional planning for effective instruction in TEL environments (Lim & Chai, 2008), and more attention needs to be paid regarding how to engage students in productive collaboration (Hämäläinen & Arvaja, 2009).

Many researchers have reported the beneficial effects of computer-supported collaborative learning (CSCL) (e.g., Koschmann, 1996; Light, Littleton, Messer, & Joiner, 1994). According to Faulkner, Joiner, Littleton, Miell, and Thompson (2000), computers may have a unique role to play in facilitating shared collaborative activities although there is no unified theory of CSCL. A common feature is to focus on how collaboration supported by technology can facilitate joint construction of shared understanding, meaning, knowledge, and expertise among the group or community (Arvaja, Häkkinen, & Kankaanranta, 2008; Dillenbourg et al., 2009; Littleton & Whitelock, 2005). According to Arvaja, Salovaara, Häkkinen, and Järvelä (2007), collaboration is defined as a shared knowledge construction in which it is not enough that participants cumulatively share knowledge together, but the *knowledge construction has to be built on others' ideas and thoughts* (Mercer, 1996). The main idea of collaborative learning is that a group creates something that exceeds what any one individual could achieve alone (Stahl, 2004) through joint creation of understanding (Littleton & Whitelock, 2005), collaborative knowledge construction (Arvaja, 2007; Baker, 2002), negotiation of shared meanings (e.g., Pea, 1993), elaboration (e.g., Hamilton, 1997; Van Boxtel, Van der Linden, & Kanselaar, 2000), mutual explaining (e.g., Webb, 1989), and reasoning (e.g., Bargh & Schul, 1980). Therefore, collaborative learning depends on interactions between group members (Arvaja et al., 2008). As groups of learners become creative participants of collaborative

* Corresponding author at: Finnish Institute for Educational Research, P.O. Box 35, University of Jyväskylä, FIN-40014 Jyväskylä, Finland. Tel.: +358 14 260 3301; fax: +358 14 260 3201.
E-mail address: raija.h.hamalainen@jyu.fi (R. Hämäläinen).

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knowledge construction (Sawyer & deZutter, 2009), learners need to be assessed differently in collaborative learning environments than in traditional classrooms (Laurillard et al., 2009).

At their best, CSCL environments can facilitate higher-level cognitive achievements such as explaining, reasoning, questioning, and elaboration (Hakkarainen, Lipponen, & Järvelä, 2002; Häkkinen, Arvaja, & Mäkitalo, 2004; Scardamalia & Bereiter, 1994). However, this kind of optimal collaboration is rarer in computer-supported learning settings (Järvelä & Häkkinen, 2002; Lipponen, 2001). Research has shown that when learners are left on their own, they rarely engage in such productive interactions and knowledge-generative activities (Kobbe et al., 2007) that are usually achieved in connection with corresponding pedagogical practices. Many pedagogical practices in CSCL have been based on unguided or minimally guided instructional approaches. However, evidence from empirical studies over the past decades consistently indicates that minimally guided instruction is less effective than instructional approaches that emphasize the guidance of the student learning processes (Kirschner, Sweller, & Clark, 2006). Moreover, as CSCL tools usually offer a fairly open collaboration space where learners are in the centre of the communication process (Bourguin & Derycke, 2001), there is an evident need to search for ways in which collaboration could be made more frequent and effective.

Supporting collaboration is more complicated than designing detailed instructions in technical environments (Arvaja et al., 2009; Hämäläinen, 2008). Effective instruction is about facilitating and engaging students' knowledge construction activities that involve higher-order thinking as intentional processes to solve authentic problems within a collaborative social context (Lim & Chai, 2008). One way to improve the level of collaboration is to structure interactions for the computer-supported learning period. Structures that construct collaborative processes are called collaboration scripts (Dillenbourg, 1999). Collaboration scripts are scaffolds that aim to improve collaboration through structuring the interactive processes between learners (Kobbe et al., 2007; Kollar, Fischer, & Hesse, 2006). The purpose of the scripts is to evoke interactions that have been found (e.g., in cognitive and educational psychology studies) to be strongly related to learning (e.g., Cohen, 1994; Webb & Palincsar, 1996). The scripts are assumed to lead to higher-level cognitive processing and better learning outcomes (Kobbe et al., 2007).

This study employs collaboration scripts as a pedagogical method to facilitate learners' group work in shared problem solving (Hämäläinen, Oksanen, & Häkkinen, 2008). In this context, scripting is seen as a proffer for learners' group work. The core design principle of scripts can vary. For different learning goals, there are different design principles through which scripts are expected to trigger specific interactions. The most well-known core design principles include *conflict*-oriented scripts (e.g., Dillenbourg & Jermann, 2006), scripts based on *reciprocal activities* (e.g., Palincsar & Brown, 1984), and different variants of *Jigsaw*. For example, "ConceptGrid" (see Dillenbourg & Jermann, 2006) is a Jigsaw type of script (Aronson, Blaney, Stephan, Sikes, & Snapp, 1978) and utilizes complementary knowledge construction by providing students with different pieces of information and distributing the knowledge among students.

There is a difference between setting up conditions for interaction and guiding interaction in a detailed level. Micro-scripts give students detailed guidance to produce specified activities such as asking thought-provoking questions or constructing arguments through which certain learning outcomes are expected. On the other hand, macro-scripts concentrate more on general ideas and on how to set up conditions in which collaborative activities such as argumentation should occur (Dillenbourg & Jermann, 2006; Kobbe et al., 2007). This study uses macro-scripts (cf. Dillenbourg & Tchounikine, 2007) that outline the general phases of the task for the participants to trigger and guide collaboration between them. From the aspect of collaboration, macro-scripts lie between sociocultural approaches and instructional design (Dillenbourg & Tchounikine, 2007). Macro-scripts aim to be flexible resources, which result in rich collaborative interactions between participants (Dillenbourg & Tchounikine, 2007). Learning in a sociocultural setting is seen as a situated social activity (Sutherland, Lindstrom, & Lahn, 2009). Within macro-scripts, the main focus is on not the task output, but the process (e.g., what happens during the interaction), which differs greatly from settings where the produced output is most important (Tchounikine, 2008). In other words, macro-scripts emphasize the interpretation of a sociocultural approach that focuses on the role of mutual engagement and shared knowledge construction in collaboration (Lipponen, 2001).

Research on scripting CSCL has concentrated chiefly on reviewing the connection between micro-scripts and individual learning (e.g., Kollar et al., 2006; Schellens & Valcke, 2006; Weinberger, Stegmann, & Fischer, 2007), whereas much less is known about the effects of macro-scripts on collaboration within groups in authentic learning contexts. This study is an attempt to fill this knowledge gap, as it primarily focuses on macro-scripts as a pedagogical method to facilitate group collaboration in authentic educational settings. This study examines the difference between the "ideal" script (the particular learning activities that the script is expected to produce; cf. Kobbe et al., 2007) and the "actual, realized" script, that represents what really happens in the scripted learning setting (Dillenbourg & Jermann, 2006). It also examines how collaboration differs between different groups in scripted conditions. Special attention has been paid to the resulting group processes and the kinds of roles adopted by students.

2. Method

2.1. Participants and procedures

Structured around sociocultural theoretical principles, different scripts were employed to enhance the probability of particular kinds of collaboration processes. The participants ($N = 30$) of the study consisted of first-year teacher education students (names are pseudonyms) taking courses in the pedagogy of pre-primary and primary education. The students participated in an authentic university course; the selection of the technology environment was directed by the official choice of the university. The script was introduced in the face-to-face meeting, and then the course was orchestrated in the Web. The students worked in seven small groups assigned by the teacher. The asynchronous Optima environment was most commonly used and supported. Using Optima, students worked in a Web-based learning environment comprising an asynchronous discussion tool, a tool for creating text documents, folders containing course material such as the teacher's lecture notes, articles in the PDF format, and hyperlinks to Web sites. Hence, the students' communication can be characterized mainly as text-based collaborative use of technology, rather than use of collaborative technology as a scaffold for knowledge construction (Lipponen, 2001). The leading idea of the study was to structure the student groups' collaborative activities by means of a particular collaboration script, whilst they were working in an asynchronous Web-based learning environment. The script gave guidance on how to proceed through and solve the learning task, but did not interfere with the detailed social interaction. The teacher, who can be considered as an expert of sociocultural theory (with a doctoral degree in education and many years' teaching experience), had previously used collaboration scripts in a larger study (see Hämäläinen & Arvaja, 2009).

The pedagogical idea of the script was designed as a joint effort by two research groups, while the content of the script was designed by the teacher. The aim of the script was to design collaboration between team members and prevent "free riders" (see Kerr & Bruun, 1983) (i.e., to activate all students) by requiring individual work as part of

the script (Dillenbourg, 2006). The script used in this study combined "ConceptGrid" (cf. Dillenbourg & Jermann, 2006), especially mutual explanation (Webb, 1989), and the idea of resolving cognitive conflicts (e.g., Doise, 1985). In this experiment, "ConceptGrid" was modified, and the students were expected to work on a controversial education policy topic on whether pre-primary education should be organized at school or at kindergarten instead of working on concepts. The teacher had used this task in face-to-face situations where it had triggered conflicts. Therefore, the topic was expected to create a cognitive conflict in a Web-environment as well. In many studies, students' differences in terms of knowledge or perspectives are stressed as a prerequisite for cognitive conflicts (e.g., Dillenbourg, 1999) and learning (Kneser & Ploetzner, 2001).

In the script, students were expected to go through five different phases. Moving from one phase to the next presupposed that the previous task was completed. However, the students were not penalized in anyway when they failed to complete a phase in the script. First (1), the groups received different sets of theoretical background information (for each participant), which the students allocated within the group. The aim of this procedure was to create interdependence among group members by producing opposite but complementary resources for the students (see Kobbe et al., 2007). In the second phase (2), each student read his theory material and made a visit to a relevant site of pre-primary education (school or kindergarten). The aim of this phase was to offer authentic experiences (e.g., Brown, Collins, & Duguid, 1989; Kirschner, Beers, Boshuizen, & Gijselaers, 2008) and add meaning to the personal roles established in the first phase. In the third phase (3), each student filled in a table with his views and definition of the topic, based on the background information and the visit (different views aiming at cognitive conflicts). The aim of this phase was to make the opposite sides and opinions visible and clear for the group members. In the fourth phase (4), each group had a shared discussion in which students had to formulate final statements around the topic while heeding the opposite points of view (at this phase, a cognitive conflict between opposite views was expected to occur). In the final phase (5), each group had an analytic discussion about how well it had been able to construe the task and complete the final statement.

2.2. Data collection

The set of data consists of records of computer-based activity: log data on student activities, asynchronous Web-based discussions during the scripted task, the final statements produced, a self-report questionnaire, and written feedback. The Web-based discussions took place in a specific virtual learning environment over a four-week period. Within this Web-based learning environment, 352 postings were sent during the course, and seven sets of final statements were produced. The self-report questionnaire prompted the students to rate their experiences of the challenges faced in different tasks. This information was elicited by means of 12 questions and written feedback (Järvenoja, Järvelä, & Volet, submitted for publication). The self-report questionnaires and written feedback were used as background data to describe the students' overall interpretations of the group activity.

2.3. Data analysis

To find out the difference between the "ideal" script and the "actual, realized" script (i.e., what really happened in the scripted learning setting), and how the groups differed despite using the same scripted environment, the following four steps were taken: (1) verifying data, (2) examining whether the groups followed the structure of the script, (3) analyzing whether the group work was collaborative or non-collaborative, and (4) comparing the main differences between the groups.

In the analysis, all data were *verified*; the entire material was read through several times, and logged redundancies (such as double entries in documents or repeated messages) were omitted. Whether students were active during the script and the *degree to which they followed the script* were examined. This was done by categorizing students' rate of participation (Part 1: Amount of Activity) in terms of a) the overall activity of all students during the macro-scripted exercise (how many students were active in each phase of the script) and b) the rate of participation of individual students in each phase. The goal of examining *whether the groups followed the structure of the script* (Part 2: Quality of Activities) *was completed after analyzing collaboration within different groups* (see the next section) by examining if the script generated a resolution for cognitive conflicts and mutual explanations, as expected in the core pedagogical idea of the script.

In addition to the amount of activity, it was essential to discern whether or not students followed the script in collaboration. Therefore, the groups were *identified as collaborative and non-collaborative* ones based on how and in what kind of activities the students participated. The collaborative groups used shared knowledge construction in which new knowledge was built on others' ideas and thoughts (Arvaja et al., 2007). However, not all members of these groups were necessarily collaborative. In other words, unequal participation in collaborative groups did not automatically spoil other members' collaboration. At this step, the analysis was modified from the analysis of the prototypical roles in CSCL (see Hämäläinen & Arvaja, 2009; Strijbos & De Laat, 2007). According to Strijbos and De Laat (2007), students' roles in collaborative learning situations can be identified in three dimensions: group size, student orientation, and effort. All groups in this study were small. Student orientation during group work was categorized either as towards individual goals or as towards the group goals. The effort and the impact that students made in the group work were investigated. Effort is not the same as impact: one's influence within a group is not directly dependent on the amount of one's contributions. Participants identified as collaborative did not skip scripted phases and engaged in high-level discussions. Such engagement was shown, for example, in elaborative questioning, mutual explaining, reasoning, and resolving cognitive conflicts (e.g., Doise, 1985; King, 1989; Van Boxtel et al., 2000; Webb, 1989). The prototypical roles (see Strijbos & De Laat, 2007) of the "free rider", "over-rider", and "captain" were also identified.

Finally, an investigation was made to find out how the groups differed despite the same scripted environment. In order to identify the main differences, the *groups were compared* in terms of the activity level, collaboration, prototypical roles, and students' personal experience of the group work. Each group was examined as a sum of its participants' group processes. At this stage, different data sources (activity levels, the number of messages, content of the messages [with the researcher's interpretation], the final statements of each group, the self-report questionnaire, and written feedback about the group work) provided corroborative evidence in addition to information obtained by other means (Silverman, 2001).

3. Results

The findings indicate a difference between the ideal script and the patterns that actually emerged with different groups in the scripted collaboration. We demonstrate how scripting guided the group work by describing the overall activity during the script as well as the difference between the ideal script and actual activities in the discussion phases of the script. We illustrate differences between the groups in terms of collaborative and non-collaborative groups. Four collaborative groups were characterized by mutual explanation. Three groups did not solve the task in collaboration, or their discussions

tended to be simplistic, lacking elaborative questioning, mutual explaining, and reasoning.

3.1. Activity levels and general features of the study process

Originally, 30 students started the course, but two of them eventually dropped out without finishing the script. For the remaining 28 students who passed the course, scripting guided collaboration by ensuring that all groups were able to get through the task and that every student contributed to the efforts. Regarding the time limits, six groups kept in pace with the timeline set by the script, whereas one group (Group 3) exceeded it by over a week. During the script, four out of the 28 participants skipped one or more of the phases of the script. However, even in the least active phase of the script (Phase 5), 24 students were active. The participation varied between the different phases in terms of individual participants' activities. At the end of the script, all groups were able to formulate their final statements.

In the first three phases, students followed the ideal script, and there was only one "free rider" (a member seeking maximum benefit from the group task with minimum personal input) (Kerr & Bruun, 1983). In the first phase in which students *received different sets of theoretical background information* (for each participant) *that the students themselves allocated within the group,* all 28 students were active. From the second phase, we could not get exact participation rates for reading the theoretical background material, but *27 students made a visit* to a relevant education site. In the third phase, 27 *students filled in a table* and also argued for their respective points of view.

The Grid script required individual efforts from each student, if they wished to participate and go through the script. However, differences between the ideal script and students' activities emerged in the last two phases. The fourth phase (Web-discussion) was a very active part of the script, and all 28 students participated in shared discussions and formulated the final statements. Individual learners' contributions in this phase varied greatly, however. While the most active member (a "captain" who facilitated teamwork and team cohesion) of Group 7 sent 34 messages, a "free rider" from Group 6 sent only two messages. In this phase, participation differed from the ideal script. First, mutual explaining was hampered by the use of copying and pasting text from individual tables to conversations. Groups 1 and 4 frequently used copying and pasting. However, as described in the following subsections, the influence of copying and pasting differed. While Group 1 integrated copying and pasting into shared knowledge construction, Group 4 was characterized by non-dialogic task solving, and copying and pasting text from their individually filled tables to the Web-discussion. Second, active conflict situations with critical argumentation (as expected in the ideal script) were rare in all groups. In general, the students seemed to prefer to avoid conflicts and tended to try to solve tasks in mutual understanding, as evidenced in Excerpt 1 below.

Excerpt 1: Tony (Group 7) reflecting that it was good that the group did not have any conflicts during the script

> I agree. We did this task well. Actually, we managed to pull it through without slightest disagreement and completed it quite easily. It was less laborious than the first task. Let's keep it up!!!

In the final phase, 24 students took part. However, in this phase of the script, students' discussion tended to be very simple, without any analytic reflection on how well they had been able to construe the task and how the overall learning environment was structured. A particular problem with phases 4 and 5 was that some students used very simplistic arguments and resorted to extensive copying and pasting of text from individual tables to the conversations.

3.2. Group variations within the Grid script

Despite the scripted environment, group activities varied during the Grid script. Although 352 postings were sent, the number of messages varied between the groups, ranging from 29 to 92 messages. There were different types of groups: collaborative and non-collaborative. First, there were four collaborative groups in which unequal participation did not automatically spoil other members' collaboration. Collaboration was shown, for example, in mutual explanation, elaborative questioning, and collaborative knowledge construction (knowledge built on others' ideas). Second, there were three groups that did not solve the task in collaboration or whose discussions tended to be simplistic, lacking elaborative questioning, mutual explaining, and reasoning. The groups differed in terms of the number, content, and length of messages posted as well as the roles assumed and attitudes and personal features displayed by their members.

3.2.1. Collaborative groups with mutual explaining

Group 7 was the most active group within the scripted collaboration. The members of this group sent altogether 92 messages and were able to reach mutual explaining in shared task solving as shown in Excerpt 2 below. At the beginning of the discussion, the students described their visits, and they also referred to these experiences later on. This group had one very active member, the "captain" (see Strijbos & De Laat, 2007), while two other members also took active part in constructing the task. These three members actively discussed and constructed the task solution. Two other members contributed some work for the task. Despite their lower activity level, they brought in new ideas, and the more active members showed positive attitudes towards these two members in discussions. At the end of the task, this group reflected on different participants' varying activity levels and discussed how their collaboration could be improved.

Excerpt 2: Collaborative task solving in Group 7

> Riina: What is the child's role in preschool education?
>
> By pre-pupils, I refer to the children in preschool, not, for example, the first-graders. I don't know if this pre-pupil is an official term, but it has come across. Maybe that 'role' term is not a very good choice in this context, but I'll use it anyway because I can't think of anything better;). Please tell me if you can think of something better. Well, by these roles I mean mainly that we often expect a first-grader already to be able to concentrate for a certain period of time, for example, on learning letters, writing, etc. We can't expect, in my opinion, that a preschooler could be able to concentrate on exercises for a whole lesson hour. For preschoolers, play and active doing in general are usually a more essential role than for first-graders. So, if the preschoolers and the first-graders are in the same room, the pre-pupils often end up just sitting too much, and the activity is very "school-like", which in my opinion does not necessarily belong to their daily life. Does this make any sense? - Riina
>
> Pete: *What is the child's role in preschool education?*
>
> In my opinion, it's just like you said. School-likeness is not yet necessary for preschoolers, but learning is much more effective by other means. In my opinion, first/second-graders do not differ that much from preschoolers, but playing, fussing, and their own activeness are just as important to them. Following a lesson while sitting quietly at my desk is still hard for me, too, so how could we expect it from a seven- or eight-year old child?? Therefore, the child's role is absolutely to be an active player and s/he doesn't even have to be aware of the ongoing learning process during play. A child learns by play much better than by being "forced" by school-like means.

Ann: *What is the child's role in preschool education?*

In my opinion, you all have had good opinions, and I agree that the child's role in preschool education is/should be very essential. Like Pete aptly said, a child does not necessarily need to be aware of the ongoing learning process during play, but on the other hand, sometimes it could be a good thing to settle down after play and ask the children, e.g., "what did you learn, and why did we play the way we did?" The difference in my opinion could be that in preschool the children could still play games that come from themselves, and no one would greatly control their playing. But in the first grade, playing should certainly be fun but maybe already include some concrete learning, like in "the last bun out of the oven" game, where children learn to form a line, throw a ball, and wait for one's turn, and also cooperation.

Analytical commentary: The emerging theme of the students' collaborative approach is shown in their communication as Riina explains her understanding of the term used earlier. After this, she asks if someone knows a better term to use. She then explains her earlier opinions and substantiates them with several points. In the next message, Pete agrees with Riina and explains why he agrees with her on the role of the child. He also presents a rhetorical question and backs up his opinion. In the last part of the excerpt above, Ann builds on the other members' contributions and states that she agrees with the rest of the team. She also highlights some of Pete's previous points, and she brings up some new points in the end of her message.

In Group 3, one member dropped out from the course, and only three members were left for this exercise. Moreover, one member was rather inactive, which meant that the group work was basically conducted by two members. This group sent altogether 48 messages. The two members shared task solving with elaborative questioning, mutual explaining, and reasoning. Both of these active members reflected on their experiences and clearly indicated that the inactive member was not doing his part. They showed this by directing their messages to each other and excluding this inactive member. At the end of the script, these two members passed the last phase of the script by commenting that they had already completed the tasks, and that they had been constructing knowledge and reflecting throughout the whole exercise.

Group 1 sent altogether 39 messages. Within this group, one member dropped out from the course, and another member participated at a low activity level. Due to this, the work was mostly conducted as a dyad dialogue between two members who participated actively. Although both of the active members used some straightforward copying and pasting from individual tables, they integrated the pasted sentences into conversations and were able to construct shared knowledge (knowledge built on others' ideas and thoughts). At the end of the task, the inactive member explained her behaviour to the other members. In the reflection part, all three members were critical towards the work conducted. As one of them stated, the most important point seemed to be getting the work done.

Group 5 sent 50 messages, and all members were very active in this group. Three of the four members reached mutual explaining in shared task solving. The fourth participant was also active although his attitude towards the others was not supportive. This participant can be classified as an "over-rider" (cf. Strijbos & De Laat, 2007) with high individual learning goals and a tendency to impose his own approach to the task on the rest of the group. This fourth participant had very high expectations about the quality of the work and about the others' participation in the group work. He also had a quite dominating attitude towards the work, and he repeatedly indicated in his messages that the level of work did not meet his standards. Despite this, the positive thing was that he kept on activating discussions by posing elaborative questions. Problems occurred, however, when he tried to ask the others' opinions; he was not able to formulate his messages in a way that the other members would have found appreciative. In the reflection part, one of the active members actually tried to give him a hint about the effect of his behaviour on the group work. Despite this problem, this group's work was very good. In the discussion, they used mutual explaining, analytic reasoning, and elaborative questioning. At the end of the task, the group was able to formulate shared solutions to the task.

3.2.2. Non-collaborative groups with simplistic discussions

Group 4 was the most inactive group within the Grid script. The members of this group sent altogether 29 messages. In some parts of the task, the group did not even reach discussion; the work was non-dialogic, consisting of monologues in which the students were copying and pasting text from their individually filled tables to the Web-discussion. In the discussion phase, the group did not pose any elaborative questions, and their performance was very poor in terms of their reflections in the last phase as well as references to the reading material. In one message, one member (Riku) even copied and pasted his opinions directly from the previously filled in table as an attempt to respond to the current task, but none of the other group members answered this message. However, at the end of the task, the students were quite satisfied with the final result.

In Group 2, four members were active, and they sent 43 messages even though the students experienced problematic long-term discussions. This might have caused students' rather simplistic statements around the topic. The group did not present any elaborative questions. Some group members used straightforward copying and pasting within discussions. The lack of deeper reasoning in these statements created problems since students mainly repeated their earlier views from Phase 3.

In Group 6, four of the members were active, whereas one can be classified as a "free rider". They sent 51 messages but did not make deeper elaborations of their work. The group had discussions, but the problem was that most contributions tended to be short (with no reasoning, mutual explaining, or elaborative questioning) and simple (based on common knowledge rather than background readings or visit experiences), as shown in Excerpt 3 below. However, at the end of the task, the group was quite pleased with the work and did not indicate any need for being more elaborative or critical. In fact, one member stated that it was an achievement to go through the task without any disagreements.

Excerpt 3: Simple statements in Web-discussion

What is the role of an adult in pre-primary education?

Paula: The adult is the one who plans, organizes, and implements the activities. S/he encourages children in new challenges and seeks to create a safe learning environment. The teacher acquires and supplies new knowledge and is also him/herself learning all the time.

Helen: True! I think that one of the important tasks for the adult is to observe what the child is interested in and plan teaching accordingly

Paula: Yes, that was a good point!

Analytical commentary: The emerging theme of non-collaborative simplistic discussions can be seen in short and simple statements in the above excerpt. Paula gives a simple explanation about the role of an adult in pre-primary education. Helen's comments on Paula's answer are very short without elaborative questioning or deeper analysis. Paula then agrees with Helen.

4. Discussion

According to recent studies, promoting students' productive (e.g., argumentative and elaborative) collaboration in the TEL environments is a challenging task for the teachers (Arvaja et al., 2008; Lim & Chai, 2008). As distributed or distant working over computer networks will play an increasingly important role in the future—not only in the field of learning but also in working life—new pedagogical methods are needed. Furthermore, since free-form collaboration does not systematically facilitate productive collaborative learning, teachers need tools and models to structure and manage students' group collaborative situations (Arvaja et al., 2009). This study explored collaboration macro-scripts as a pedagogical method to facilitate collaborative learning. When considering the findings, all limitations of a case-study approach should be kept in mind. However, the advantage of this study is its focus on collaboration scripts as a pedagogical method to facilitate students' group collaboration in macro-scripted authentic learning contexts, which we do not currently know much about.

The study had two main goals. First, the aim was to find out the difference between the "ideal" script and the "actual, realized" script (i.e., what really happens in the scripted learning experiment). The script ensured that all groups were able to complete the task, and all participants indicated some activity during the work. The script required individual efforts from each student, which meant that students either contributed to some work or failed to go through the script and dropped the course. Scripting kept the process going in an orderly manner, without skipping phases of the script, and there was only one "free rider" among all these groups. Despite this positive effect, some critical issues also came up. The biggest problem concerned the differences in individual learners' contributions at each step of the script. Six groups had members who were hindering, rather than promoting, collaboration within the group. While scripting might have increased the quasi-activity of some students who were not really committed to the actual group work, it also led to simplistic discussions or even prevented more active members' collaboration.

The second aim was to find out how different groups' activities vary despite the same scripted environment and to identify the types of group processes in different groups. Group activities varied a great deal during the script. There were four collaborative and three non-collaborative groups. In this study, aside from students' collaboration skills (Cartwright, 1968), high-level collaboration depended on learners' willingness and effort towards collaboration and taking responsibility for personal roles. The main problem for collaboration was unequal participation in the group work. One of the non-collaborative groups (Group 4) resorted frequently to copying and pasting text, while two other groups' discussions tended to be simplistic, lacking elaborative questioning, mutual explaining, and reasoning. In contrast, high-level collaboration (knowledge construction built on others' ideas) seemed to be connected to students' equal interaction, in which they were explaining, reasoning, and questioning their own and their peers' actions or views (Baker, 2002; Barron, 2003). In this study, a specific problem was related to the nature of the task. First, the possibility to copy and paste text from individually filled in tables caused a lack of reciprocal discussion. Second, a task that would create a conflict in face-to-face situations did not necessarily work the same way in the virtual environment. Students did not enter conflict situations in virtual environments as easily as in face-to-face discussions (Baker, 2003), which sets a challenge for the future design of learning environments. The challenge is how to design environments that can trigger cognitive conflicts, which at their best can enhance high-level learning (e.g., Howe & Tolmie, 1999).

New technologies (e.g., Web 2.0) set new strains on supporting collaborative learning as teachers have to integrate these new technologies into more or less traditional learning methods, curricula, and school's everyday life (Arvaja et al., 2009). Collaboration scripts offer a way to support and foster productive collaborative learning (see Dillenbourg & Jermann, 2006; Hämäläinen et al., 2008; Mäkitalo, Weinberger, Häkkinen, Järvelä, & Fischer, 2005; Schellens & Valcke, 2006). The findings of this study corroborate the notion that well-designed macro-scripts can enhance the use of educational technology. This study demonstrates that macro-scripts supported collaboration by introducing the reason (core pedagogical idea) for interaction and by helping students to solve learning tasks. However, macro-scripts did not guarantee high-level collaboration.

This study indicates that different groups act differently despite using a similar script. Therefore, different groups need different kinds of support in their interactions. Scripts should be interpreted as flexible resources and as a design metaphor for finding the delicate balance between too little vs. too much control to facilitate and allow for flexible group interactions (Baker & Lund, 1997; Dillenbourg & Tchounikine, 2007). In this view, collaboration scripts are interpreted as instructional sequences that prepare students for and make them reflect upon collaborative learning but do not interfere with detailed interactions since it is too fragile, complex, and unpredictable to be regulated by a predefined script (Stahl, 2006).

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