T. Koschmann, D. Suthers, & T.W. Chan (Eds.), *Computer Supported Collaborative Learning 2005: The Next 10 Years!*
Mahwah, NJ: Lawrence Erlbaum Associates.

Collaborative Scaffolding in Synchronous Environment: Congruity and Antagonism of Tutor/Student Facilitation Acts

Kai Pata
Science Didactics Department,
University of Tartu
kpata@ut.ee

Tago Sarapuu
Science Didactics Department,
University of Tartu
tago@ut.ee

Raymond Archee
School of Communication, Design and Media,
University of Western Sydney
r.archee@uws.edu.au

Abstract. This paper focuses on the theoretical framework for investigating facilitation acts of the tutor and the students in problem-solving groups as reciprocally congruent. We propose to broaden the scaffolding debate in collaborative teams towards the areas of students' shared metacognitive and cognitive grounding acts. Similar tutor-supported and untutored science-related dilemma-solving activities in network-based synchronous mode were categorically analyzed and compared with respect to their scaffolding acts. We asked the question, whether there emerges the collaborative scaffolding situation in teams and how does tutor influence the peer scaffolding. Results indicated the presence of several scaffolding actors in collaborative teams. The nature of activity (tutored or untutored) had an influence on the practice of specific supportive acts by the tutor and the students. The various interrelations between student and tutor scaffolding acts must be considered when preparing the tutor support during problem solving.

Keywords: collaborative scaffolding, synchronous learning, supporting dilemma solving

INTRODUCTION

In this paper we explore the functioning of a variety of support systems, which occur during collaborative problem-solving activities in synchronous network-based settings. As a result of interpreting specific discourse acts in the frames of dialogue act theory (see Clark & Schaefer, 1989; Traum & Allen, 1994; Traum 2000), we suggest broadening the scaffolding metaphor in collaborative teams by conceptualizing student grounding and tutor facilitating acts as being reciprocally congruent. This new framework highlights collaborative scaffolding issues and enables the study of inter-relations of different-level scaffolding actors in teams.

Collaborative scaffolding situation

Two parallel approaches have been developed for understanding the support processes in teams – one has focused on students in symmetrical collaborative learning situation, whilst the other has concentrated on the tutor in asymmetrical groups. There are few studies, however, which combine these two approaches while interpreting the interactions in tutored collaborative learning situations.

The research in untutored problem-solving groups relates to peer support in both metacognitive and cognitive domains. These support-acts are seldom interpreted as scaffolding. Support in the metacognitive domain is usually viewed from three perspectives. The first is 'self-regulation', where students support themselves in teams (Lipponen, 2001); the second is 'team-level metacognition', which focuses on team-level metacognitive reasoning related to the task and interaction (Jermann, 2002); and the third is 'socially-mediated/socially shared metacognition', a reciprocal process of exploring each other's reasoning and viewpoints in order to create a shared understanding of the task (Goos, *et al.*, 2002; Iiskala, *et al.*, 2004). The support in cognitive domain is viewed as 'shared cognition' – the cognitive level grounding in order to construct shared knowledge (Dillenbourg & Traum, 1999). Rasmussen (2001) and Fernandez *et al.* (2001) assume, however, that whole communication can be viewed as the mutual and partly unconscious 'scaffolding', which invites participants to follow the implicit ground rules and develop and test their own constructions of meaning with others.

The research about promoting collaborative learning considers the influence of the more skilful and knowledgeable tutor or trained peer-tutor on students learning. In terms of facilitation there is a general trend to view the tutor as the coordinator and the students as the performers of the task-directed learning process. This conception of scaffolding has its roots in research about the relationships between the teacher and the learner in dyadic well-defined problem-solving situations. According the scaffolding metaphor defined by Wood *et al.*, (1976), an adult has to *'control those elements of the task that are initially beyond the child's capacity, thus permitting him to concentrate upon and complete only those elements that are within his range of competence'*. Vygotsky (1978) has assumed that teacher creates the conditions for certain students' cognitive processes to develop, without directly implanting them in the child. He defined the idea about the Zone of Proximal Development (ZPD), which is *'the distance between the actual developmental level as determined by independent problem-solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers'* (Vygotsky, 1978, p.86). The more knowledgeable person was believed to influence students' cognitive processes in the range of their ZPD.

Transferred to the collaborative learning situations, the initial theory about the ZPD and the scaffolding metaphor could be developed further in order to explain the phenomena at the group level. Wells (1999) argued that ZPD applies potentially to all participants not simply to the less skilful or knowledgeable ones. In accordance with this, the ZPD concept was explained as the bi-directional teacher-learner and learner-learner ZPD (Forman, 1989; Goos *et al.*, 2002). Goos *et al.* (2002) describe the ZPD as the learning potential in small groups where students have incomplete but relatively equal expertise and where each partner who possesses some knowledge and skills requires the others' contribution in order to make progress. At the level of understanding thematic information in relation to certain task and learning goals, continuous grounding processes between the team members must take place (Veerman, 2000). These interpretations of mutual ZPD and scaffolding diminish the role of more knowledgeable tutor and open the possibility of viewing all the members in learning group as possible scaffolding actors.

We also posit a similar origin for the tutor's regulatory phenomena and the cognitive/metacognitive grounding acts, which take place between students in teams. If confirmed we can begin to think of a combined collaborative multi-actor scaffolding situation between the students themselves or the students and the tutor in teams.

Congruity of peer grounding and tutor scaffolding acts

The utterances of all the team-members are delivered as 'dialogue acts' during communication (Traum, 2000), regardless if there are only students or if a tutor is involved. Clark and Schaefer (1989) distinguish two types of individual acts: 'autonomous acts' are those that an agent performs on his or her own and 'participatory acts' are performed as parts of collective acts. The latter type of acts can be related not only to shared metacognition and cognition, but also to scaffolding.

Most of participatory acts begin with an action by A, the contributor. The process of contribution divides conceptually into two phases: i) 'presentation phase' when A presents utterance for B to consider and ii) 'acceptance phase' when B accepts utterance by giving evidence that he believes or understands what A means. In collaborative teams tutor and students can perform both phases of the participatory act. It is also clear that several actors may respond to any presentation phase act, and acceptance phase acts can serve as new initiators of participatory acts.

Luhmann (1992) distinguishes three concepts related to communication: information (something that is in the head of the actor), utterance (something what the actor spells out/writes) and understanding the difference between information and utterance (how the other actor interprets the information in utterance). The latter is dependent on the other actor's state of mind i.e. their intentions. Thus, effective communication in team depends on mutual understanding and grounding of each other's intentions during participatory acts.

As much of one's behavior arises from sense of obligation to behave within the limits set by the society that the agent is part of, Traum and Allen (1994), and Traum (2000) have proposed the communication model that is based on obligations and goals. Obligations represent what an agent should do, according to some sets of norms. When planning, an agent A considers both its goals and obligations in order to determine an action; when deciding what to do next, the obligations are considered first and the agent B decides how to update the intentional structure (add new goals or intentions) based on these obligations. Obligations might also lead directly to immediate action. If there are no obligations, then the agent B will consider its' intentions and perform any actions which can satisfy these intentions. If there are no intended conversational acts, the next thing the actor B considers is grounding. Generally, grounding is considered less urgent than acting, based on communicative intentions, although some grounding acts will be performed on the basis of obligations, which arise while interpreting prior utterances (Traum, 2000). According to these discourse rules, it is possible to propose that the hierarchical structure of participatory acts starts from actor B considering the perceived obligations and intentions proposed by actor A. The next step occurs when the clear intentions of actor B govern his discourse acts. Grounding is an option to negotiate the intentions and obligations between two actors.

Clark and Schaefer (1989) and Traum and Allen (1994) have listed several acceptance phase types between two actors: accept, take action, partial accept, adopt, request for, clarifying obligation/intention, displacement with another obligation/intention, reject, and repair obligation/intention. Applying the hierarchical order of discourse acts, these can be viewed as more or less dominating in the discourse, depending on the actor B understanding of his intentions during the activity. This general model can be used in explaining participatory acts between the students in team, as well as, between tutor and the students.

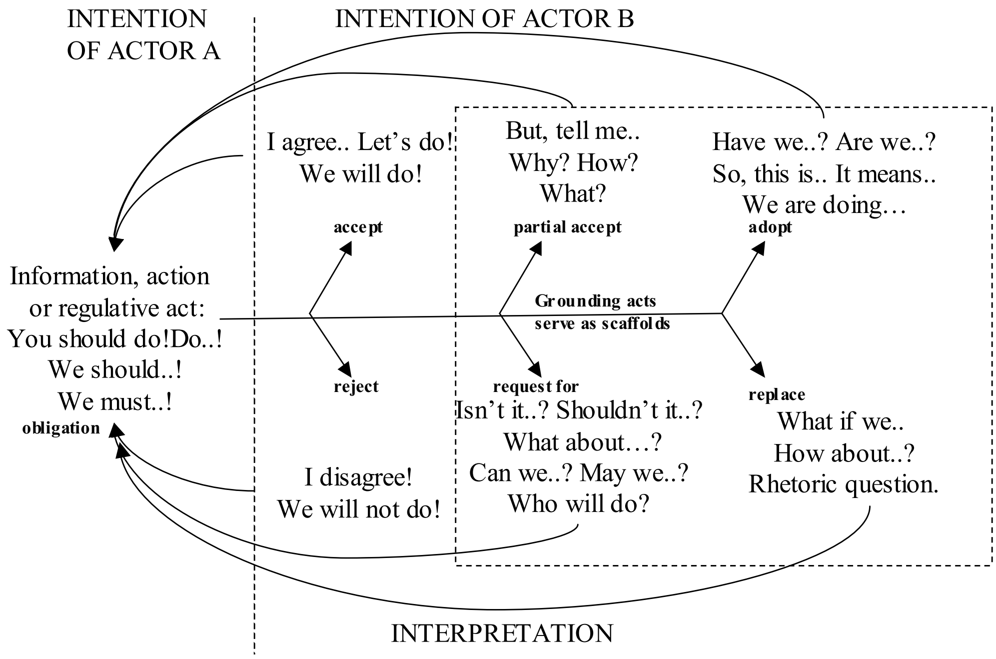

Figure 1. The flow diagram of discourse acts between the actors in non-tutored collaborative team.

Figure 1 presents a model of different level dialogue acts in collaborative team without tutor. The actor A has an intention to share some information or change something in the team by regulative act. It formulates an utterance that will be interpreted by any team-members (actor B) according to their intentions. Information can be agreed or rejected by actor B if it does/does not coincide with their intentions or if they do not have intentions of their own. This type of reply often terminates the discussion about this topic. Information or instruction can cause the teammates to initiate grounding if the intentions of actor A are not clear to them or if their intentions are different. These grounding acts may be of accepting type, when actor B agrees to actor A in general, but needs some more information (partial accept). Actor B may also reformulate the information/supposed-action-he-has-started-to-perform/instruction with its own words in order to control the coherence with the intentions of actor A (adopt). Grounding acts may also be of rejecting type if actor B feels that there is a confrontation with the intentions of actor A or if there is not enough information to perform any action (request for). Second type of rejecting act can be replacement of proposed information or instruction with its own (replace) that indicates to the difference between the intentions of actors A and B. Both the accepting and rejecting type of grounding acts can, in turn, initiate negotiation between the team-members. Thus, grounding acts in team serve like internal scaffolds, which help to establish common ground in cognitive and metacognitive domains and the collaborative scaffolding situation emerges. This interpretation is in coherence with the ideas about bi-directional ZPD (Forman, 1989; Goos *et al.*, 2002) and scaffolding as the form of communication (Rasmussen, 2001; Fernandez *et al.*, 2001).

The participatory acts in the discussion can be related with the scaffolding function (e.g. scaffolding interactions introduced by Graesser *et al.*, 1995; Chi *et al.*, 2001). Participatory support acts that involve instructional scaffolding serve as discourse 'oligations' with the purpose of setting rules, setting conditions, setting restrictions, terminating, accepting or rejecting students' action or information. Participatory support acts that do not involve obligations, but favor some type of activity can be interpreted as 'intentions'. These may be practiced to scaffold the students in cognitive, metacognitive, affective and functional areas in order to help them to finish the task. Many 'intentions' and 'obligations' serve as grounding acts.

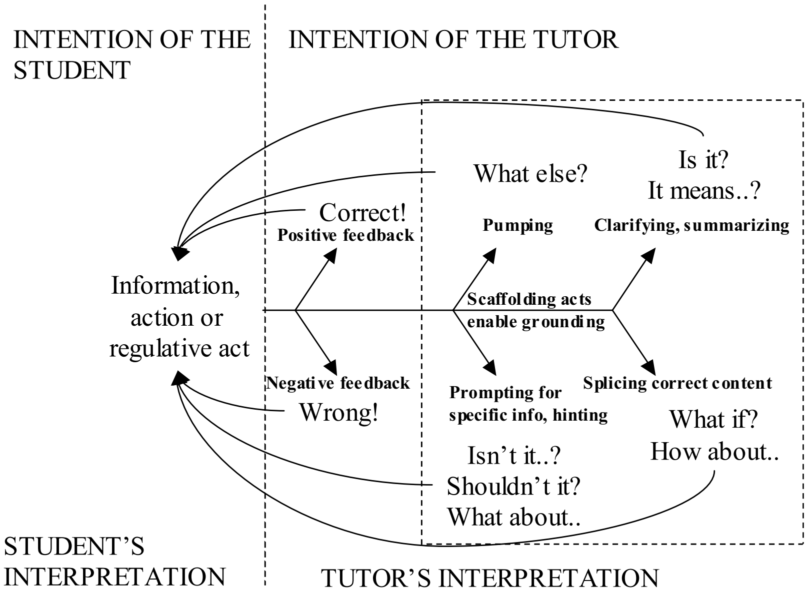

Figure 2. The flow diagram of scaffolding acts between the tutor and the student.
The scaffolding dialogue move categories by Graesser *et al*. (1995) have been adopted.

Figure 2 presents a model of dialogue acts in the collaborative team scaffolded by the tutor. In this model the tutor dialogue move categories, proposed by Graesser *et al*. (1995), have been used. If the student gives some information to the tutor or performs an action, the tutor interprets it in accordance with its own previous teaching intentions and the anticipated behavior of the student. The tutor scaffolding in response to student act can be direct accepting or rejecting (e.g. positive or negative feedback), partial accepting (e.g. pumping, clarifying, summarizing) or partial rejecting the information/action (e.g. prompting for specific information, hinting, splicing correct content). Student information or action may be agreed or rejected by the tutor if it does/does not coincide with its' teaching intentions. This type of support may be more common in coaching dialogues in which the tutor's aim is to support the student to reach the certain result.

In contrast to accepting/rejecting behavior, the tutor's task on scaffolding is not to coach the completion of the task but the student understanding how to conceptualize the task through the proper steps of action (Stone, 1998). In order to make scaffolding successful, the student's partial *'comprehension of the solution must precede production'* (Wood *et al.*, 1976) and the learner must have the *'ownership of the activity to be learned'* *(*Langer & Applebee, 1986; Järvelä, 1996). The student must be enforced to participate in active turn taking with the tutor (Palinscar & Brown, 1984; Järvelä, 1995) to evoke the internalization of new knowledge and skills. Elbers *et al.* (1992) support the idea that the basis for internalization is not the adult's situation definition, but the jointly elaborated situation definition of two actors. Thus, the tutor should use scaffolding acts that trigger students' grounding acts in metacognitive and cognitive domains. The partial accept type of scaffolds represent the tutor's intention to find coherence with students' intentions. When using the partial rejecting type of scaffolds the tutor is clinging to his own intentions that might decrease the students' active participation in joint elaboration of the task situation.

The comparison of certain types of student grounding and tutor scaffolding acts in teams indicate their similar purpose that can be related to the construction of the cognitive and metacognitive team coherence. The tutor has to identify the student understanding of the situation and the task, their perception of the tutor intentions, and their perception of themselves in the task framework. Besides the tutor, each student has to understand how their peers perceive the situation and the task, how they see themselves and the tutor in this situation, and what the intentions of the others might be. We may conclude that in the collaborative situations scaffolded by the tutor several scaffolding agents may exist simultaneously. The student grounding acts in teams can be theoretically interpreted as scaffolding acts, while the tutor scaffolding acts can be interpreted as grounding acts.

The inter-relations of student and tutor scaffolding acts

When planning the learning activities in synchronous environment it is important to know what type of facilitation patterns might be prevailing during the discourse between students in symmetrical learning situation and in the discourse where the tutor is involved. If we can show that scaffolding phenomena are part of common discussion practices among students working in team alone, the interpretation of the influence of tutor scaffolding in facilitated learning situations must be re-conceptualized. In order to assess the effectiveness of scaffolding in such situations it must be taken into account how the students might have performed on their own with self-scaffolding, how they performed with the tutor's support, and how the tutor's support might have influenced the usage of students' scaffolding acts.

Much more knowledge is needed in order to understand the influence of multi-actor scaffolding on team performance. It is open to question whether students and tutor are acting coherently in teams, considering the scaffolds applied by others (e.g. modeling or co-scaffolding), or does there emerge antagonism between two types of facilitating agents. The effectiveness of elaborating coherence between the tutor and the student scaffolding intentions in teams on students' problem solving and decision-making has been described in dyadic situation (Elbers *et al.*, 1992) and in collaborative teams (Pata *et al.*, in press). For effective regulating the group problem solving by tutor, it is of importance to investigate what types of tutor scaffolding acts can potentially inhibit or decrease the usage of specific student scaffolding acts common to untutored collaborative situations.

This paper aims to compare two similar cases of solving dilemma problems collaboratively in synchronous network-based environment in respect of the practice of specific types of scaffolding acts common to the tutor and the students. Firstly, in order to clarify, whether there is a reciprocal congruency between students' cognitive and metacognitive grounding and the tutor's scaffolding acts, we wish to discover, which types of scaffolding acts are common in untutored and tutored learning situations. The findings about the similarity of students' grounding and tutor's scaffolding acts should, in turn, enable us to consider the existence of multi-actor scaffolding situation in tutored learning teams. Secondly, in this paper we do not intend to compare the influence of these different level scaffolding actors' support acts on the team decision-making but to investigate whether the presence of the tutor might have influenced the usage of scaffolding acts by students. Thus three research questions were formulated:

i) Which support acts characterize the untutored and tutored collaborative dilemma-solving discussions in synchronous chat-rooms and is there a congruity of students' regulative grounding and tutor's scaffolding acts?

ii) Does there occur the collaborative scaffolding situation in tutored teams where several actors (tutor, students) perform mutual scaffolding?

iii) Is there a significant difference between the usage of students' scaffolding acts in collaborative untutored and tutored dilemma-solving activity which might suggest the emergence of concurrency and antagonism phenomena between the students' and tutor's scaffolding acts in the tutored situation?

METHODS

The data for this paper were collected from two separately designed experiments investigating decision-making in synchronous environments (Archee, 2004; Pata & Sarapuu, 2003; Pata, *et al.*, in press). During both studies students in synchronous network-based chat-room carried out the similar dilemma-solving discussions. In this paper we have reanalyzed the collected discussion transcripts from these two studies in respect of the practice of scaffolding acts. The activities were the following:

ACTIVITY 1. Dilemma solving without tutor in text-based mode (Archee, 2004).

Participants of the Activity 1 were 40 BA students of Communication aged 17-19. The task was to discuss in chat-room and to reach consensus upon the dilemma issue "Should it be law that HIV-AIDS positive carriers must disclose their medical condition to would-be employers, doctors, dentists, or even going for a driver's license?" Students were divided randomly into groups of 5-13 members who logged in to the network-based chat-room of Internet Relay Chat. They were not anonymous. Five decision-making discussions with total number of 1614 discourse acts were conducted with different students. The activity started with attributing the printed handout of the problem statement to the students. The activity lasted about 1 h and ended when the consensus was established from the viewpoint of the participants.

ACTIVITY 2. Dilemma solving with tutor in text-based mode (Pata & Sarapuu, 2003; Pata, *et al.*, in press).

Participants of the Activity 2 were 62 secondary level students aged 15-17, and 2 trained tutors. The task was to discuss in chat-room and to reach consensus upon the issue "What must be done with neglected dogs in cities?" The activity was designed as a role-play with jigsaw movement starting from making decisions in role-groups (Dog-owners, Dog-protectors, Citizens and Dog-asylum workers) and then negotiating these decisions in groups of experts (Councils of Town A and Town B) where the members from each role-group were at present. Five decision-making discussions with total number of 2077 discourse acts were conducted. In each role-play the students were initially divided randomly into four role-groups with the membership of 2-5 and during the activity they were redirected to the expert-groups with the membership of 4-7. In the beginning of the activity the students logged in to the certain virtual rooms of the network-based chat-room of Collaborative Virtual Workplace (CVW). The participants were anonymous, identifying themselves with certain names from the role-play (e.g. citizen1, citizen2). The activity started with attributing the web page with problem statement to the students. Verbal tutor support (instructions and prompts) and the web-based information about some important aspects of the problem for certain role-group (e.g. legislation about dogs, ethical considerations, economic calculations for dog-asylums) were also available in each virtual room. The role-play activity lasted about 1 h and ended when consensus was established by the expert-groups and they had composed the short decision document of the team.

The discourse in teams was recorded by the system and transcribed. On the basis of the theoretical framework introduced in this paper (see Fig. 1 and 2) the category-system was developed for investigating the scaffolding acts of the tutor and students. The seven types of scaffolds – *obligation, accept, partial accept, adopt, reject, request for*, and *replace* – were distinguished both in cognitive and metacognitive domains. Although possible, we did not categorize agreeing and disagreeing types of content-related responses under accept and reject categories of scaffolds because the intentions of these acts could be interpreted ambiguously. The examples of student and tutor scaffolding acts are presented in the Results part.

The frequency of different types of scaffolding acts was found both for students and tutor. The percentages of different scaffolding acts served as the basis of characterization of two activities. The Cross tabulation and the Chi square analysis were performed with student scaffolding acts in order to compare the usage of support acts in untutored and tutored situations.

RESULTS

We aimed to investigate, which types of scaffolding acts are used in cognitive and metacognitive domains by the students and the tutor in two activities. The category system was theoretically sustained by the idea that scaffolding and grounding acts in teams are used for similar purposes. The categories were developed according to the general intention types of dialogue acts. We considered all these discourse acts that were used to regulate the establishing of common ground between the intentions of the students and the tutor as scaffolding acts.

The following examples in Table 1 characterize different types of students' and tutor's scaffolds. The findings indicated that the student and tutor scaffolding acts were similar and differed from each other mainly in terms of the targets of the acts. The students directed the scaffolds most often towards themselves in teams, but also to some teammates or they left the responder open. The tutor was mainly directing the orders to the unspecified or to the concrete student, positioning himself outside the team. Moreover, in some cases tutor practiced scaffolding as an equal member of the team by using similar self-directed discourse acts like students.

Table 1. Examples of different types of tutor's and students' cognitive (C) and metacognitive (MC) scaffolds.

Discourse act categories		Peer's regulatory and grounding acts, which serve as scaffolds	Tutor's scaffolding acts that initiate grounding
Obligation	C	*We need to look at past cases to understand the implication involved in this topical discussion!*	*You, as animal protectors, must decide what to do to enhance the situation of neglected dogs.*
	MC	*We must find a better method to solve this problem!* *We must add corrections and make it better!* *We should make this picture better!* *To protector 6: Somebody should make the decision now!* *Choose the color! To protector 4: send us something to read, we want to discuss.*	*We should pay attention to the problem!* *Stay in your discussion room, you will meet other groups later on!* *Make the decision-document visible to everybody!*
Accept	C	*Let's discuss why people take themselves dogs without responsibility!*	*You can now discuss what the animal protectors think of this decision.*
	MC	*Let's just come to a decision and be finished with this!* *Ok Kathy, let's lead the discussion!* *To protector 4: we will decide!* *We will add the ideas in a minute.* *I will draw some line on the picture!*	*After you have read it, let's start discussing in the chat-room how to solve the problem.* *You can copy all the separate decisions into one to compound the decision of the animal protectors.* *If the leader has made the decision document we will make it visible to evaluate it.*
Partial accept	C	*What kind of laws??* *How can you infect others, when hospitals and other places are supposed to be clean?* *Why disclosed?*	*What bothers you the most in concerns of neglected dogs? How to control it?*
	MC	*Fine guys, what do you have to recommend then?* *What must we do with this model?*	*After reading the text the discussion will start – what must you do to solve the problem of neglected dogs?*
Adopt	C	*Okay, so have we agreed that aids should be disclosed in some circumstances i.e. medical and blood transfusions? So, is that our decision?*	*We have decided that dogs must be taken care of?* *Owner, do you agree that the dog owners are guilty in causing the problem and must take the responsibility?*
	MC	*Are we done then? Is our work ready?* *Do we have a consensus?* *Have we reached a consensus?* *We have reached a consensus.*	*Do you have consensus?* *Have you in principal agreed with the decision?*

Reject	C	*Hey, better if we will not start lecturing there.*	
	MC	*Don't' hurry!* *There is nobody from Tartu!* *The owner disagrees to be the leader!*	*Don't write dotted letters!* *You are wasting time, citizen7!*
Request for	C	*Are we going to talk about AIDS or what?* *But isn't it important in cases where there is a blood transfusion taking place?* *Janine, what about car accidents, the ambulance attendants need to know?* *Maybe not a badge, but how about some info on your license?* *Does anyone disagree, that such info should not be disclosed?*	*What do you think, are you satisfied with your decision from the point of view of animal protectors?* *Why the dogs are fierce – isn't it the fault of their owners?* *Should the neighbors take a look if the other people's dogs ok?* *Can all people take dogs?*
	MC	*Did you read the supplementary material?* *Have you read the supplementary material?* *Can we reach an agreement?*	*Are there any ideas how to make the decision draft better?* *Protector 6, is your decision getting ready?* *Could you write new ideas to your decision?*
Replace	C	*To protector 6: What if to organize the neighbors' guarding service?*	
	MC	*Protector 4, don't sleep, be active!* *Excuse me, Allison you should be concentrating on solving this problem, not talking to some guy in Kingswood!*	*Owner1 is in wrong room, he must be in another room!*

It appeared that during both activities the students and the tutor practiced various cognitive and metacognitive scaffolding acts. Thus, it can be assumed that in teams we must talk about collaborative scaffolding situation and consider the inter-relations of the student and the tutor scaffolds. Table 2 presents the frequency of different types of student and tutor facilitation acts in two activities. The usage of scaffolding turns among other types of discourse acts appeared to be more frequent (43 %) in tutored Activity 2 than it was in untutored Activity 1 (23 %). The significant difference ($X^2(3)=447.19$, $p<0.001$) between the activities was found in the usage of scaffolding act types. In untutored Activity 1 the usage of grounding type of scaffolds was noticeably higher and the cognitive scaffolds prevailed, whereas in tutored Activity 2 the '*obligation'* was the most frequent scaffolding act type and the majority of scaffolds were metacognitive. The higher level of instructional support in Activity 2 was partly explainable by the jigsaw design – the students worked in role- and expert-groups and had to move between different virtual rooms of the learning environment. Therefore some additional coordination of the activity was necessary by the tutor.

Table 2. The distribution of scaffolding acts in untutored and tutored dilemma-solving activities.

Scaffolding act types	Usage of scaffolding acts					
	Dilemma solving without tutor in chat-room		Dilemma solving with tutor in chat-room			
	students		students	tutor	students	tutor
	Metacognitive	Cognitive	Metacognitive		Cognitive	
Obligation	34 (9%)	7 (2%)	87 (10%)	238 (26%)	2 (<1%)	9 (1%)
Accept	31 (8%)	1 (<1%)	68 (8%)	21 (2%)	1 (<1%)	6 (<1%)
Partial accept	10 (3%)	102 (27%)	53 (6%)	7 (<1%)	43 (5%)	31 (3%)
Adopt	11 (3%)	25 (7%)	26 (3%)	10 (1%)	4 (<1%)	31 (3%)
Reject	0 (0%)	10 (3%)	9 (1%)	1 (<1%)	2 (<1%)	3 (<1%)
Request for	42 (11%)	79 (21%)	94 (10%)	52 (6%)	56 (6%)	39 (4%)
Replace	5 (<1%)	17 (5%)	1 (<1%)	2 (<1%)	7 (<1%)	0 (0%)
Total	374 (100 %)		903 (100 %)			

In this paper we were concerned, which types of regulative acts characterize the students who discuss dilemma without tutor. This type of activity could serve as an example of natural regulation processes in teams. We found that the most common metacognitive scaffolding acts used by students were *'requests for'* prompting specific information or action (*Can we reach agreement? Who will make the decision?*), directive and accepting type of orders (*We must...! We should…! Let's discuss..!*) from the *'obligations'* category. The most frequent cognitive scaffolds were pumping for info, which comprised *'partial acceptance'* of earlier info (*But how can you infect others if hospitals are supposed to be clean?*), *'request for'* additional info, which included the partial rejecting of earlier info (*Maybe not badge, but how about some info on the license?*) and *'adopt'* type of facilitation acts for clarifying or summarizing the situation (*Ok, so we have agreed that AIDS should be disclosed in some circumstances? So is that our decision?*). In the tutored situation the students' metacognitive scaffolding was persistent with same frequency, besides which the tutor practiced frequently the *'obligation' (Leader, you must make corrections in the note according to your team-members' decisions!)*, *'accept'* (*You can copy all the separate decisions into one to compound the decision of the animal protectors!)* and *'request for'* (*To protector4: send us something to read, we want to discuss!)* type of scaffolds, increasing the level of metacognitive scaffolding in teams. The practicing of cognitive type of scaffolds did not follow the same pattern. In tutored activity both the students and the tutor practiced less cognitive scaffolds compared with the untutored situation.

In order to investigate how tutor may influence the natural team performance the usage of student scaffolding acts during solving dilemma problems in untutored and tutored activity was compared by Chi square analysis (see Table 3). It was clear, that the design of the study did not enable us to make direct inferences about the tutor's influence on the usage of students' scaffolding acts in Activity 2. Yet, the similar nature of Activities 1 and 2 enabled of making predictions about the difference of the collaborative process of solving the dilemmas with or without the presence of several scaffolding actors. It was found that, in the tutored activity the student metacognitive scaffolds (*partial accept*) were used with significantly higher frequency ($p<0.001$) than in untutored situation. The opposite trend was common in untutored activity where students' cognitive scaffolding acts (*adopt, request for)* occurred with significantly higher frequency ($p<0.001$) than in tutored activity. It cannot be assumed, however, that if there was no tutor in Activity 2, the dilemma-discussions were performed more effectively. Among the investigated cases very different patterns of practicing the scaffolding acts were observed. Some tutored groups might not have been working effectively if there was no scaffolding by the tutor (see Pata *et al.*, in press). In some untutored teams, on the other hand, the problems occurred with focusing on the task, and the students might have needed additional external support (see Archee, 2004).

Table 3. The results of the Cross tabulation and the Chi square analysis of student scaffolding acts in untutored and tutored dilemma solving activities.

Scaffolding act types	Count of students' scaffolding acts (Std. Residual)				Chi square (df)	p
	Untutored situation	Tutored situation	Untutored situation	Tutored situation		
	Metacognitive		Cognitive			
Obligation	34 (-0.7)	87(0.5)	7 (2.5)	2 (-1.7)	9.57 (1)	0.002
Accept	31 (0.1)	68 (0)	1 (0.5)	1 (-0.3)	0.316 (1)	0.57
Partial accept	10 (-4.1)	53 (4.4)	102 (2.7)	43 (-2.9)	52.43 (1)	0.001
Adopt	11 (-2.0)	26 (2.2)	25 (2.3)	4 (-2.5)	20.91 (1)	0.001
Reject	0 (-2.1)	9 (2.0)	10 (1.8)	2 (-1.7)	14.31 (1)	0.001
Request for	42 (-2.4)	94 (2.2)	79 (2.4)	56 (-2.2)	20.93 (1)	0.001
Replace	5 (0.3)	1 (-0.5)	17 (-0.1)	7 (0.2)	0.38 (1)	0.53

The significant differences in the usage of peer's scaffolding acts in the tutored situation compared with the untutored one, as well as, the tutor's high practicing of metacognitive and low usage of cognitive scaffolding acts enabled to question, whether there occurred concurrency or antagonism phenomena between student and tutor scaffolding acts in Activity 2. The tutor's most common scaffolding act type was metacognitive instruction (*obligation*). It was not clear, however, how effective the extended usage of *'obligation'* acts by the tutor was during the Activity 2, because the students performed this type of scaffolding same often as in untutored Activity 1. We propose that the concurrency processes like i) tutor's modeling of the instructional behavior for students, and i) tutor's self-elaboration of his own scaffolding intentions in order to meet better the students intentions in team, as well as, antagonistic trends like iii) tutor's reformulation of students' metacognitive scaffolds according to his own intentions, or iv) tutor's acting regardless of students' scaffolding could take place.

Theoretically, in Activity 2 tutor's main aim should have been facilitating the student cognitive scaffolding acts what might have favored students to establish common ground on the dilemma solutions. In accordance with these suppositions, it was found that the student cognitive types of scaffolds were more frequent than those of the tutor in Activity 2. So we can think of some cognitive modeling processes taking place in the area of this type of scaffolds and assume that the tutor might have been considering flexibly the scaffolding acts performed by the students. On the other hand, in Activity 2 the student cognitive type scaffolds were used less frequently than in Activity 1. The cognitive type of *adopt* function (e.g. *You have now decided...*) was performed extensively mainly by the tutor in Activity 2, which might have inhibited the students from attempting clarification or summarizing of their discussion results that was common in untutored Activity 1. It may be that the presence of certain tutor scaffolds might have decreased the student responsibility for scaffolding their own cognitive functions and that antagonism between scaffolding actors played a significant role.

DISCUSSION

Supported by the dialogue act theories (Clark & Scheafer, 1989; Traum & Allen, 1994; Traum, 2000), in this paper we developed a theoretical framework for interpreting student grounding and tutor scaffolding acts in groups as reciprocally congruent. We focused on some scaffolding-related phenomena that influence learning in collaborative dilemma-solving teams. These were: i) The congruity of student grounding acts and the tutor scaffolding acts; ii) The emergence of collaborative scaffolding situation in teams due to several actors performing mutual scaffolding; and the necessity to re-conceptualize the interpretation of tutor's influence on peer scaffolding; and iii) The inter-relations of student and tutor scaffolding acts in teams and the possible concurrency and antagonism between them.

In our study two similar science-related dilemma-solving learning activities in synchronous network-based environments were investigated in order to illustrate the closeness of tutor and student facilitation acts with concrete examples. We did not design these learning activities as parts of one study, thus the learning situations are not comparable in all characteristics. Our aim was not to evaluate the direct effects of the tutor's presence on student performance, but to investigate if the untutored situation is comparable to the tutored context with respect to the usage of scaffolding acts. We could find a close resemblance of facilitation acts of the students and the tutor and suggest that grounding acts serve as scaffolds and vice-versa that scaffolding acts can be interpreted as grounding acts. Nevertheless, the data from these two cases did not allow us to generalize about the congruity of grounding and scaffolding acts in other types of collaborative learning situations. It is possible that the proposed framework need to be elaborated and concretized in order to describe all the scaffold types that are used in well-structured problem-solving situations and in teams, which deal with cognitive tools used in the construction of learning artifacts. We assume that some new types of scaffolds may also be found as a result of different cultural and community practices.

It is necessary to develop a new understanding of multi-actor scaffolding for collaborative situations. We assume that for predicting and influencing the regulation and grounding processes of different types of problem-solving teams, our theoretical framework of categorizing tutor's and students' scaffolding acts might serve as a useful protocol. In order to explain the learning and scaffolding situation in teams, three types of roles should be considered: the tutor as scaffolding actor, the student as scaffolding actor, and the student as task performer. They differ from each other in the consciousness of their intentions related to the performance of the task. When interpreting the teacher-supported collaborative learning activity, we should not focus only on the teacher's intentions and scaffolding aims. Moreover, from the perspective of constructivist theory, the role of the teacher as a scaffolding agent should be to favor the learners and move them towards the elaboration of task-regulation in this learning situation.

The comparison of tutored dilemma-solving situation with "natural" untutored activity indicated that in addition to thinking about tutor modeling and scaffolding processes, we should consider that some acts of student scaffolding might not originate from external tutor intervention but rather belong to the general communication phenomena like grounding. The lower frequency of student cognitive scaffolds in tutored teams compared with untutored situation might indicate that even the presence of the teacher can decrease or inhibit learners' natural facilitation processes. The frequency analysis, performed with two similar dilemma-solving cases, left open many questions about how to explain the different distribution of scaffolding acts. Could the tutor trigger some student scaffolding acts by modeling? Did the tutor scaffolds help students to elaborate tutor instructions and prompts according to their own intentions and thus enabled them to leadership roles? Were the tutor and the students using scaffolds regardless of each other? In further studies of collaborative scaffolding phenomena in both synchronous network-based and face-to-face contexts, sequencing analysis approaches might provide a better alternative, since the various tutor and student scaffolding interaction types can be more easily related to student learning variables. Secondly, the findings of the usage of specific scaffolding acts for different learning cases (e.g. well- or ill-structured problems, or use of verbal or visual artifacts) might enable the prediction of which inter-relations the tutor should emphasize in order to enhance learning.

ACKNOWLEDGMENTS

This research was supported by grant No. 5996 from the Estonian Science Foundation and MER funding 0182542s03.

REFERENCES

Archee, R. (2004) Analyzing mediated group interaction: an interpretive approach. *World Conference on Educational Multimedia, Hypermedia and Telecommunications*, Vol. 2004, Issue. 1, 2004, pp. 4107-4114

Chi, M. T. H, Siler, S. A., Jeong, H., Yamauchi, T., and Hausmann, R. (2001) Learning from human tutoring. *Cognitive Science,* **25**, 471-533.

Clark, H. H., and Schaefer, E. F. (1989) Contributing to discourse. *Cognitive Science*, **13**, 259-294.

Dillenbourg, P., and Traum, T. (1999) Does shared screen make a shared solution. In C.Hoadley & J. Roschelle (Eds.), *Proceedings of the Third Conference on Computer-Supported Collaborative Learning* (pp. 127-135). California: Stanford University.

Elbers, E., Maier, R., Hoekstra, T., and Hoogsteder, M. (1992) Internalization and adult-child interaction. *Learning and Instruction,* **2**, 101-118.

Fernandez, M., Wegerif, R., Mercer, N. and Rojas-Drummond, S. (2001) Re-conceptualizing "Scaffolding" and the Zone of Proximal Development in the context of symmetrical collaborative learning. *Journal of Classroom Interaction*, **36(2)**, 40-54.

Forman, E. (1989) The role of peer interaction in the social construction of mathematical knowledge. *International Journal of Educational Research*, **13**, 55-70.

Goos, M., Galbraith, P., and Renshaw, P. (2002) Socially mediated metacognition: creating collaborative zones of proximal development in small group problem-solving. *Educational Studies in Mathematics*, **49**, 193-223.

Graesser, A. C., Person, N. K., and Magliano, J. P. (1995) Collaborative dialogue patterns in naturalistic one-to-one tutoring. *Applied Cognitive Psychology*, **9**, 495-522.

Iiskala, T., Vauras, M., and Lehtinen, E. (2004). Socially-shared metacognition in peer-learning. *The Journal of The Hellenic Psychological Society,* **1(2)**, 147-178.

Järvelä, S. (1995) The cognitive apprenticeship model in a technologically rich learning environment: Interpreting the learning interaction. *Learning and Instruction*, **5**, 237-259.

Järvelä, S. (1996) New models of teacher-student interaction. *European Journal of Psychology of Education*, **11(3)**, 249-268.

Jermann, P. (2002) Task and interaction regulation in controlling a traffic simulation. In *Proceedings of CSCL' 2002 Conference*, January 7–11 2002, Boulder, Colorado, USA.

Langer, J., and Applebee, A. (1986) Reading and writing instruction: Toward a theory of teaching and learning. In E. Rothkopf (Ed.), *Review of Research in Education*, (Vol. 13, pp.171-194). Washington, DC: AERA.

Lipponen, L. (2001) Computer-supported collaborative learning: from promises to reality. *PhD Dissertation.* Turku: Turun yliopisto.

Luhmann, N. (1992) What is communication? *Communications Theory*, **2-3**, 251-259.

Palinscar, A. S., and Brown, D. A. (1984) The reciprocal teaching of comprehension monitoring activities. *Cognition and Instruction*, **1**, 117-175.

Pata, K., and Sarapuu, T. (2003) Developing students' mental models of environmental problems by decision-making role-play in synchronous network-based environment. In J. Lewis, A. Magro, L. Simonneaux (Eds.) *Biology education for the real world. Proceedings of the IVth ERIDOB Conference* (pp.335-348). Paragraphic/ Groupe Lienhart.

Pata, K., Sarapuu, T., and Lehtinen, E. (in press) Tutor-scaffolding styles of dilemma solving in network-based role-play. *Learning and Instruction*.

Rasmussen, J. (2001) The importance of communication in teaching: a systems-theory approach to the scaffolding metaphor. *Journal of Curriculum Studies*, **33(5)**, 569-582.

Stone, C. A. (1998) The metaphor of scaffolding: Its' utility for the field of learning disabilities. *Journal of Learning Disabilities*, **31(4)**, 344-364.

Traum, D. R. (2000) 20 Questions for Dialogue Act Taxonomies. *Journal of Semantics*, **17(1)**, 7-30.

Traum, D. R., and Allen, J. F. (1994) Discourse obligations in dialogue processing. In *Proceedings of the 32nd Annual Meeting of the Association for Computational Linguistics (ACL-94)*, 1-8.

Veerman, A. (2000) *Computer-supported collaborative learning through argumentation.* Utrecht: Interuniversity Center for Educational Research.

Vygotsky, L. (1978) *Mind in Society: The Development of Higher Psychological Processes.* Cambridge, MA: Harvard University Press (original material published in 1930, 1933, 1935).

Wells, G. (1999) *Dialogic inquiry: Towards a socio-cultural practice and theory of education.* New York: Cambridge University Press.

Wood, D. J., Bruner, J. S., and Ross, G. (1976) The role of tutoring in problem-solving. *Journal of Child Psychology and Psychiatry*, **17**, 89–100.