

Exploring Relational Regulation in Computer-Mediated (Collaborative) Learning Interaction: A Developmental Perspective

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ABSTRACT

This article presents a qualitative analysis showing the dependency of effective collaborative argumentation on interpersonal relational aspects that develop during synchronous interaction. Four regulatory principles are proposed as propelling the interaction, and of these, auto-regulation, or the conservative restraints within the existing relation, appears to be the dominant force. When using a structured dialogue system (SDS), instead of free chat, via roles and sentence-openers, the social dimension of the relation between participants disappears from the surface interaction. Even though using the SDS seems to foster a more focused and task-functional approach, argumentation appears to affect the relation between participants in a negative way, since after an argumentative sequence, repair of the relation takes place. It might even be argued that, because of relational stress, in many cases, argumentation is momentarily suspended.

INTRODUCTION

IN AN EFFORT to support collaborative learning in synchronous electronic learning environments, the communication medium in this paper is recognized and investigated as a tool to develop and maintain a "collaborative" relation between participants. The construct of mediating collaborative relation should enable an integrated evaluation of support offered in an electronic learning environment. The perspective taken, that of a relation that dynamically develops through the interaction between participants, regulated by progressive and conservative forces, involves analyzing how the communication interface actually mediates collaboration, in contrast to evaluating the use of its designed features. Developing this

perspective, three main issues are addressed: (a) the normative perception of the collaborative relation, (b) the dynamics of the development of this relation, and (c) the relation of the abstract concept of the collaborative relation with the overt interaction that takes place during collaborative sessions.

The normative perception of the collaborative work relation

The first question in investigating "the collaborative relation" that should be addressed is what the characteristics of a collaborative relation are. However, to derive a unified conception of the concept of collaboration is a difficult, if not impossible, task.¹ Allwood² describes cooperation as a matter of degree defined by conforming to four criteria:

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(a) considering each other cognitively, (b) having a joint purpose, (c) considering each other ethically in interaction, and (d) trusting each other to act according to the first three criteria. This perception of cooperative learning clearly embeds collaboration in a solid social-relational base.

In contrast to the harmony required for collaboration to bloom,² the learning mechanisms of negotiation and argumentation rely on the creation of a socio-cognitive conflict that is developed and/or resolved in interaction.³ The schism caused by creating this (professional) conflict, while developing and maintaining a (socially) secure environment seems to be a major hurdle in developing collaborative argument-based learning. This is especially the case within an educational culture rooted in the traditional transmission scenario in which content-related issues are resolved by authority rather than by the prevailing argument.⁴

Pedagogical scenarios provide a different perspective on the quality of the collaborative relation: one that stresses qualitatively different cultures in which participants function. Within the three scenarios developed,^{4,5} the studio and the negotiation scenarios represent progressive ideologies in which knowledge is actively created and negotiated, and where learners actively participate in the process of knowledge development. This is qualitatively different from the stereotypical traditional transmission scenario, in which knowledge is factual and learners (not active participants) are receivers of knowledge. Learners in the different scenarios thus would relate differently towards both knowledge and to their co-learners.⁶

The difference between the studio scenario and the negotiation scenario is that the studio scenario is a learning-to-learn-collaboratively scenario, while in the negotiation scenario the culture has matured. As a transition scenario, especially in the studio scenario, problems can be expected on the relational plane. Participants in collaborative learning settings need to adapt to developing knowledge by using argumentative strategies, while at the same time creating and maintaining a culture fitting the studio scenario that, coming from a transmission scenario culture, is not natural to them.⁷

In short, the collaborative relation is not an intrinsic part of traditional educational culture and involves social coherence and trust to allow for cognitive dissonance. In addition to the harmonious quality of the interpersonal relation collaborative, learning interaction should be fostered by the creation of a professional collaboration culture between participants.⁸

Regulation: dynamics in the collaborative relation

In the previous section, the collaborative relation is described using concepts that are usually presented as the prerequisites for collaborative learning to take place. This could make sense where collaboration as a characteristic is attributed to the neutral but static "situation."¹ However, here it is used as a qualification of the relational state or micro-culture, representing the belief that it is the participants who actively interpret and create the situation themselves. To understand this dynamic process, the concept of regulation is used. In acting upon the development of the collaborative relation between participants, four important regulation mechanisms are distinguished: (a) self-regulation, which is a meta-cognitive principle, perceiving people as aiming to achieve personal goals,⁹ (b) task regulation, where participants are conforming to task and environmental constraints, (c) mutual regulation, as an implicit pressure mechanism to share and explain in social environments,^{10,11} and (d) auto-regulation, or the regulatory force determining contributions coming forth from relational and interactional conventions and collaborative history. This last form of regulation connects with the perception of small group interaction as "looking 'backward' in time, paying primarily attention to something noxious that had just happened rather than looking 'forward' in time and paying attention to a visualized goal achievement in the future."¹² The quote shows two important aspects of interaction: first, the reactive nature of interaction, and second, the possible conflicting nature of different regulatory principles in interaction. The perceived relation between these regulatory principles is depicted in Figure 1, showing a loop representing interaction that is affected by the different regulatory forces.

In the studio scenario, auto-regulation represents a conservative force: interaction driven by auto-regulation adheres to the established conventions coming forth from relational and interactional conventions. It thereby represents accepted interactional behavior, that is: grounded behavior. As the relation continues it can be expected to evolve by mutual regulation: new behavior would become grounded because of the perceived need to explain deviant behavior. Consequently the mechanism of mutual regulation expands the behavioral repertoire within the relation in an evolutionary sense. These two forces, auto-regulation and mutual regulation, come forth from within the existing relation. Conversely, self-regulation and task-regulation are progressive forces able to create a divergence from

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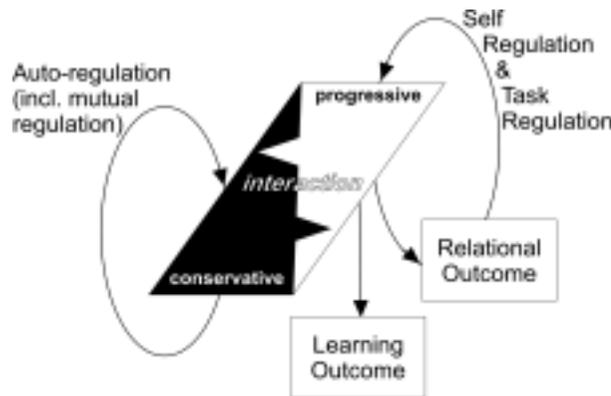


FIG. 1. The distinguished regulatory forces acting upon interaction, having a dual outcome: a relational effect and a learning effect. The balance of black and white would signify the progressiveness of the relation in which the interaction takes place.

existing natural interaction. They can be used for pedagogical purposes to change the development of the interaction by self-regulation (meta-interaction) and/or by using affordances in the electronic environment, the latter offering possibilities and restrictions (or even transformations) of communicative messages that can help change or define the relation between participants. An example of an environment where few affordances for maintaining or developing a relation are available is found in interaction via a diagram/external representation, because of its sole focus on content. Interaction through chat, the medium that is analyzed in this article, is relatively flexible and affords a wide spectrum of communicative possibilities (and would compare to diagrammatic interaction as very social).

Surface interaction and the underlying work relation

Bales¹² observation of group interaction leads to the belief that observed events were best regarded as the “overt process indicators of an underlying field of interacting events and influences (. . .), a complex system in which almost everything affect[s] almost everything else.” This underlying field is what we here conceptualize as the relation between participants. Participants, having only the overt interaction available as representing the relation, act using more or less explicit inferences drawn from that interaction. Thus, although the concept of the collaborative relation that is developed is rather abstract, it relates directly to the observable interaction that takes place, though the relation is not clear-cut. The direct relation of the

underlying relation between participants, and the overt interaction that takes place between them, opens up the possibility to influence one from the other as is attempted in the study presented here.

The experiment: design and rationale of the environmental regulation used

A structured dialog system (SDS) was imposed on the basic chat functionality. In general the intent of the SDS was to lower the total cost¹³ of producing preferred types of activities and contributions, with the goal of setting interaction in the context of the studio-scenario. Cost relates to any resistance to making a certain type of contribution, for instance technological cost (effort to type) or social cost (the perceived effect of a contribution on the relation). The intention was to lower the technical (typing) and social (attribution of relationally not accepted behavior to the environment rather than the partner) cost for studio-scenario type interactions, interactions that in the transmission scenario culture would be too costly. A more specific expectation was that the SDS would promote more prolonged shared task focus (because of the high technical cost of changing roles) by implementing flexible role-divisions to organize and steer interaction during a writing task. This intent was inspired by research by Veerman,¹⁴ in which focus changes were found to hinder learning interaction on a conceptual level. Roles could be negotiated using (continuously available) buttons that activate a pop-up screen for the partner to propose an activity relevant to the task (organize, idea generation, idea development, and writing/revising) and give options for different role divisions. These roles were signified by a set of ‘forced use’ sentence openers typical for the role chosen. Sentence openers have been used before and have shown to promote on-task interaction.¹⁵ The structuring of argumentative interaction by giving a number of options to react has also been found to be satisfactory,¹⁶ but less successful “totalitarian” regimes were also tested,¹⁷ showing that designing interaction support is a balancing act in which the user perception plays an important role.

The regulation model presented above enables the evaluation of collaborative learning environments and methods that support collaborative learning, while unexpected side effects from supportive features (or the particular implementation of such a feature) can be incorporated and do justice to the idea of collaborative learning as an intrinsically motivated activity. What is expected is that the nature (scenario/culture perspective) and

the quality (relational perspective) of the work-relation need to be developed to a certain level before argumentative learning interaction can take place.

MATERIALS AND METHODS

From a collection of dyadic (synchronous) interaction protocols from different writing tasks, performed in adapted versions of the electronic collaborative writing environment TC3,¹⁸ two randomly chosen protocols are analyzed; one from an experiment comparing optional sentence openers (but where the selected protocol was from the control group, not using sentence openers), and the other from a session using the SDS described above. Sessions were conducted in fourth year of a 6-year secondary school (ages 15–17). The writing-tasks and accompanying source materials (newspaper articles) were set up to explore conflicting positions and interests in the field of economics education.

With respect to evaluation of the SDS, the intent is not so much to find the size of a possible effect, but rather identify the rationale behind observed mechanisms within the complexities of supporting interaction. This should lead to the identification of strong and weak aspects of the SDS in supporting a proper relation and provide options to improve communication interfaces in general, instead of aiming at the specific implementation used. To achieve this, a qualitative approach was chosen, which entailed describing and interpreting interaction episodes that are demarcated by break points indicated by the participants, such as role changes or turn changes in the shared text-editor.

RESULTS

First, the focus will be on one logged collaboration between two students: Roger and Yves. The first hour of their effort is extensively described and interpreted below. Due to lack of space, only four selected episodes of the actual (translated) protocol can be included. The other episode descriptions will use examples to give insight to the interpretation given. The second protocol, using the SDS, is treated in the same manner.

Interpretation of the protocol

Before the writing task (in total two lessons, or 90 min), one lesson was spent on an introduction to the TC3-environment (15 min) and on reading of

source materials, which consisted of opinionated newspaper articles and interviews about the topic of environment-conscious entrepreneurship (half an hour). Participants were asked to individually construct a diagrammatic representation of the information that they found important. For the collaborative sessions, dyads were assigned by matching the participants on the elaborateness of the produced diagrams. The diagrams were then scanned and placed in the electronic environment as source material; however, considering the handwritten nature of the diagram, the scanning often resulted in difficult to read material, as was the case with this dyad.

Starting episode. This episode (Table 1) could be broken down in three main sub-episodes; first a greeting (18–23), then agreement on the task goal is achieved (24–43), followed by a decision about the position the dyad shall take (52–66). The interaction about the two task-related points takes respectively six and five turns, quite long compared to the rest of the interaction sequences taking place (usually two or three turns).

In the “greeting sub-episode,” the members of the dyad establish a positive attitude towards each other, partly by the shared negative evaluation of the visual quality of their products (21–22). Roger’s explicit agreement has to be socially founded since it is not based on a real evaluation: evidence is found in the complete logs where it becomes clear that he has not looked at the products yet, and as additional evidence, later on Roger attempts to focus Yves attention to the products (32) when he has seen them.

Roger, by asking Yves what they are supposed to do, also initiates the next “goal-setting sub-episode” resulting in the agreement of both not knowing. One minute and a half later, Yves does formulate a goal that is simply agreed on by Roger. The manner in which this happens suggests the established relation as one in which showing reservation (or putting in the least possible effort) about task related matters is accepted or even appreciated.

Again it is Roger who initiating the third sub-episode, by asking Yves’ opinion on the position to take. Yves avoids this question initially, but Roger appears persistent, and forces a choice with a more direct question (61). Yves choice then is (unsurprisingly) simply agreed upon by Roger.

The general picture shows Roger dominating the interaction; his focus seems to be on achieving a positive relation, though at the same time though he makes himself dependent on Yves, who appears to be the more knowledgeable partner. Yves in his

TABLE 1. THE STARTING EPISODE FOR YVES AND ROGER, COMMUNICATIVE ACTIONS USING THE ENVIRONMENT (RATHER THAN CHAT CONTRIBUTIONS), ARE PLACED BETWEEN BRACKETS

<i>Line</i>	<i>Time</i>	<i>Partner</i>	<i>Contribution</i>
18	0:00:33	Roger	He Yves, everything all right?
20	0:00:42	Yves	Perfect
21	0:00:52	Yves	Those products are f***ed up
22	0:00:57	Roger	I agree
23	0:01:01	Yves	Good
25	0:01:15	Roger	Do you know what we have to do now?
26	0:01:20	Yves	Not really
27	0:01:23	Roger	Me neither
29	0:01:48	Yves	Now I'm receiving a stencil with my product on it
32	0:02:15	Roger	You should look at product
38	0:02:54	Yves	We have to make up a position about our last products
41	0:03:03	Roger	Ok
43	0:03:12	Yves	Just look at the assignment top-right
46	0:04:09	Yves	Are we still getting info
52	0:05:36	Roger	What did MVO mean again
56	0:05:50	Yves	Societal Responsible Entrepreneurship
57	0:05:56	Roger	What's your opinion
60	0:06:12	Yves	No idea, I'm reading the article
61	0:06:13	Roger	Are we pro or against
64	0:06:23	Yves	Let's just go pro
66	0:06:26	Roger	K
71	0:06:54	Yves	Will you start writing the piece
78	0:07:17	Roger	[Accesses text editor]
80	0:07:22	Roger	[Hands over control]

turn dominates content-wise, making all the decisions. Yves' concern for content is also supported by the (ignored) request (46) in which he asks if there will be more info to come. Roger's concern seems to be "being in agreement with anything Yves brings up". The combination results in a shallow decision making process (and a slightly negative task approach), but is contributing to a positive foundation of a relation based on social aspects/agreement (even though concern is largely about task related decisions).

Episode 2. In contrast with the suggestion at the end of the former episode, Roger puts Yves to work in this first content contributing episode. After they have grounded their task goal, at least partly, the main 'contributing phase' is interrupted by an exchange started by Roger.

Roger actively ignores Yves' prompt in the first episode (Table 1, 71) by handing over access to the text editor (Table 1, 80). Roger rephrases the decision (to go pro) in: "Thus we think the government should get involved more with MVO" making the de-

cision more concrete and grounding it. This is confirmed by Yves' following acknowledgement, but he also adds to that "but we have to react to an article," further refining the task-goal, and having the final word in this exchange. However, this refinement doesn't get incorporated in Yves' contribution (an introductory paragraph) that states the task-goal for as far as it is grounded at that time.

Roger, not paying attention to Yves' writing, starts exploring the source material, then comments on the bad readability of Yves' product (on which Yves already had commented in the first episode). The evolving sequence shows Yves' solidarity (and patience?) with Roger, by in the end offering that he just should ask if he wants to know something (and with that also inclining towards a more superior position). Yves closes off his contribution by handing over control of the text-editor and asking for an evaluation, to which Roger's positive response comes a bit too quick (not allowing for a proper time to evaluate it, thus again socially motivated), while actually the text is quite unclear and gives enough reason for him to ask some clarification.

What is visible here is consistent with the first episode, Roger verbally initiates all three sub-episodes, but Yves appears the dominant factor. Again agreement is visible based on social relational aspects. With the initial (conscious?) attempt by Yves of placing Roger in a content contributing position having failed, reinforcement of the existing relation seems to have occurred by a process of auto-regulation resulting in a socially based and content-wise uncritical approach.

Episode 3. This episode (Table 2), like the second one, starts off with Yves prompting Roger to contribute. The easiest way to understand the episode is assuming that the partners have two (related) monologues simultaneously: they do not listen to

each other and remain largely stuck in their own preconceptions. Yves is trying to let Roger contribute while Roger aims at a role division with himself reading a source (pointed out by Yves) and Yves contributing text. Roger's option is accepted (172) by an explicit "thank you" for receiving control over the text after a failed last attempt by Yves (156). The "thank you" indicates (as a minimum) an acceptance of the situation, but could also be interpreted as very cynical, or as finally resigning.

Remarkable is the non-functionality of Yves' contributions/interruptions with respect the goal of letting Roger contribute. But, with his contributions he actually levels with Roger in communicative manner: initiating interactions (132, 133, 140) while focusing partly on social appreciation of his

TABLE 2. EPISODE THREE FOR YVES AND ROGER, TEXT CONTRIBUTIONS
(WHICH ARE LOGGED ON TURN CHANGES) ARE BETWEEN < >

<i>Line</i>	<i>Time</i>	<i>Partner</i>	<i>Contribution</i>
131	0:13:53	Roger	[Accesses text editor]
132	0:14:11	Yves	Are you gonna write in the text
133	0:14:26	Yves	What do you think of my typing skills?
135	0:14:42	Roger	Great
136	0:14:50	Yves	K
137	0:15:06	Roger	What should I write in the social text
138	0:15:14	Roger	[Accesses text editor]
139	0:15:18	Yves	An argument in favour of our position
140	0:15:36	Yves	Oh, did you see the article in the program already
142	0:15:49	Yves	Top-right with the tabs
146	0:16:05	Roger	No, I'll read it
147	0:16:18	Roger	In the meantime, do you want to write
148	0:16:20	Roger	[Hands over control] <Second, . . . >
150	0:16:21	Roger	
156	0:16:24	Yves	For arguments you can look in your diagram
157	0:16:26	Yves	[Hands over control]
164	0:16:31	Roger	[Accesses text editor]
166	0:16:38	Roger	[Hands over control]
172	0:16:48	Yves	Thank you
173	0:16:49	Yves	[Accesses text editor]
175	0:18:07	Roger	What is in the article is quite useful
178	0:18:35	Roger	Who is Lodewijk
180	0:18:57	Yves	He was mentioned in the articles we received in class
181	0:19:14	Roger	Is he a supporter
182	0:19:26	Yves	I think so
183	0:19:45	Yves	This at least is what he said. It's in my diagram
185	0:20:01	Yves	Will you write
187	0:20:03	Yves	[Hands over control] <Second, according to Lodewijk de Waal of FNV, for many companies it is not clear what MVO exactly means. If the government would get involved more, this would not be the case.>

effort (133). The “dialogue” is indicative of failing self-regulation in developing the relation between the partners towards a more equal stance, but while failing in self-regulation, in this episode the dyad still manages to effectuate (auto-regulation) a change in Rogers approach being more pragmatic (proposing a task division) and content focused (inquiring about the contribution by Yves, 178, 181) and also results in Yves’ interaction style to be more on a par with that of Roger.

Episode 4. This time Roger doesn’t escape his turn to contribute, although he tries. In a first attempt he communicates: “*I’m having a difficult time,*” a comment to which a non-response follows. Two and a half minute later, the silence is broken by Roger, “*Yes, but we first write down what we can and correct it the next lesson.*” Yves reaction is to the spelling mistake (coorrect instead of correct), using humor in pretending not to know what is meant, showing attentiveness to his partners’ actions. Roger’s remark (yes, but . . .) is significant in that it achieves two things: it establishes a proposal on how to attack the task, but foremost it defines the text as a work in progress. The collaborative history so far, and the earlier remark followed by a long pause, gives rise to the interpretation of Roger’s contribution as an anticipatory excuse for the level of his text-contributions. The process of mutual regulation puts pressure on Roger to conform (or explain his non-existing contribution) that results in him creating an opening for himself by changing the text-status. Yves then, while Roger is contributing, engages in social talk (an anecdote and continuing on the theme of typing skill) to which Roger, while contributing, responds.

It seems like roles have turned, or rather that both partners have expanded their repertoire. The social exchanges, and also the episode-closing turn-change (Roger: “*ok then*” as he is finished, and Yves: “*shall I do something again*”) indicate trust and ease with each other. The exchange is mostly neutral in affect, this in contrast with the socially based agreement provided by Roger before, and is social talk that is not related to the task itself.

Episode 5. In this episode an argument (duration 10 turns, 5 min, 30 sec) takes place about how to interpret a source, their interpretation of the source clashes in that Roger interprets it as countering their position, while Yves interprets it as supportive. In the argument the original position is not questioned, but rather the text should be adapted to the position taken. Yves manages an explanation that Roger can agree with, suggesting “*then you*

should write that down.” Yves response, “*otherwise we cancel it,*” indicates that he wants to quit the argument. Roger next puts the interests and bias of the source forward, but at the same time Yves contributes “*otherwise you correct it then*” and gives text control over to Roger, in effect closing the discussion. Surrounding the argumentation is social interaction: before by comparing their effort positively against other dyads, afterwards by evaluating their collaboration positively. The latter seems to indicate an appreciation of each other and release of tension after the intense argumentation, in which the ‘tone of voice’ gets a little unfriendly, and Yves’ focus is not on developing the content anymore but on ending the argument.

And further. After this episode, the first hour is almost finished and they close off. The next hour they get to work together (the following day), the dyad has apparently prepared some material, copying this into the text, and thereby altering the situation. The interaction has changed, focus is on finishing the text, no arguments are developed any more, and affective components in the interaction (as scored using Bales’ IPA) disappear altogether. For these reasons, the remainder of the collaborative effort is not relevant here and is not been further investigated.

Protocol summary. The relevant questions are why and how this first (and only) content relevant argumentation came about at this specific moment, and why Yves ends it by withdrawing from the argument. The model that is laid out in the introduction suggests that the relational conditions are now created to initiate the argument, but apparently not right to resolve it by argument. So what are the observed conditions? From the first episode(s) it would be hard to predict that it would be Roger that initiates an argument. A development in the relation towards more equality is visible through the episodes, culminating in the content-wise contribution by Roger that opens up the possibility for argumentation, as if it were giving him the right to judge on his partner. That it is Yves who is eager to discontinue the argument is more difficult to explain from the relational development over the episodes. From the local (within the episode) conditions of the argument, the relational aspects seem important in ending the argument. Added to this, Yves might feel put in the defense a bit (after a diminishing dominance on the content-level, and the persistence of Roger) and therefore would be the likely candidate to end the argument.

A general problem observed in the interaction is the synchronization of the ‘agenda’ of both partici-

pants: their focus in relation to what they (individually) try to achieve in the episodes is almost constantly different (social versus content-wise): the argumentation only develops when Roger actively focuses and comments on Yves' writing effort. The argument that then develops appears focused on fact seeking and the correct interpretation of source material (indicative of a transmission culture). It is regulated by awareness of social aspects of the relation (also transmission) and giving up on pursuing further argumentative debate, instead choosing to repair their relation. In auto-regulation, as a conservative force, maintaining the created context is visible in an extended effort and difficulty to change the relation. Although finally it takes only one remark for Roger to change his position in the collaborative effort, Yves has repeatedly tried to get Roger involved. This crucial contribution by Roger that enabled him to participate on the content-level is very likely an outcome of mutual regulation, rather than of self-regulation, and thus not an intended effort to change the situation.

Interpretation of the second protocol: using the SDS

The second protocol, by Dan and Chris, used a different task-setup due to progressive insight and practical arrangements in the school. Differences are that the source materials (newspaper articles) are included in the environment, that the introduction to the environment was not hands-on, but a written instruction explaining the environment using screen dumps, that the session took place in one session of three hours, and that the decision to be for or against a position was eliminated since this decision did not serve opinion formation and development (as illustrated by the first protocol used here). The last (relevant) difference is that in this case a partner was chosen instead of assigned (Table 3).

Starting episode. In this first episode, Dan and Chris get a sense of the environment and of the assignment. A structure in their interaction, as in initiation-response sequences, is not really visible, instead they inform each other. From what they are informing on, it seems that Chris is much more focused on the workings of the SDS by trying out some buttons, while Dan's contributions are revolving around task goals, ending up suggesting the immediate goal of reading sources (111), which they do (apparent by a pause in contributions of about 5 min). Not much interaction is visible looking at the dialogue, but when one includes the role-negotiation exchanges as contributions, the in-

teraction becomes visible. Chris's role changing the initiation (22) for example, is an immediate response to Dan's suggestion to come up with arguments (21); Dan, however, does not understand this communicative action as (33) shows.

Since the partners use the sentence openers here, it is more difficult to say anything about their interrelations, although in communicating through the sentence openers the interaction that takes place is task-oriented and lacks an effective tone and therefore does not affect that aspect of the relationship. The deviations of the intended use (the roles initiated are not played out, and the sentence openers are [consequently] not used as intended) show a positive relation: the joking use of a sentence-opener by Chris in formulating a correct sentence with no meaning (20), and Dan's argumentative rebuttal (42) shows flexibility using the sentence-openers and a sense of freedom towards each other in formulating frankly and even communicating uncertainty (also contribution 33).

Quantitatively Dan is dominant in the interaction, but this doesn't make Chris her subordinate: the two move rather independently from each other, hence the slowness of the episode which took almost 15 minutes. This slowness is undoubtedly caused by the SDS, which makes people think in advance about what they want to communicate. That it is Dan who breaks the silence between them (reading sources) is a further indication of her dominance, taking the lead in task-progression.

Episode 2. In this episode, short from an interaction perspective, (it takes ten minutes and they are still reading as well) Dan begins an introductory paragraph stating the goal of the letter in progress. This is followed by a chat contribution: "*important (in the discussion) is Turkey is a big country, the possible war-activities take place in the east, where hardly any tourists are,*" stating what will later on develop into the topic of the argument. Dan continues to dominant the interactions. She asks Chris, in the text window, to convey his ideas through the chat, thereby keeping control of the text herself. However, a few moments later, she decides to shift control over to Chris for a change (Table 4).

Episode 3. In this episode Chris is contributing content to the text, while Dan is commenting on it. They seem to share a focus on the production of the text. An argument develops here from a comment on the text. They disagree about whether to stick to the facts or to bend the truth to attract customers. The dyad seems to have developed a division here, an idea that is strengthened by the choice of the ap-

TABLE 3. STARTING EPISODE FOR DAN AND CHRIS, THE SENTENCE OPENER PHRASES ARE UNDERLINED

<i>Line</i>	<i>Time</i>	<i>Partner</i>	<i>Contribution</i>
4	0:00:00	Dan	[Hands over control]
11	0:00:34	Chris	[Accesses text editor]
13	0:01:02	Chris	[Role negotiation: organize]
20	0:01:17	Chris	What's missing is monkeys
21	0:01:32	Dan	We first have to come up with our arguments
22	0:01:49	Chris	[Role negotiation: discuss/competitive]
33	0:02:42	Chris	I don't get it 100%
42	0:03:39	Dan	I oppose to that with nothing, how do you make those pop-up appear with me all the time
46	0:04:10	Dan	[Role negotiation: organize]
49	0:04:33	Dan	Okay
58	0:05:11	Dan	Before we start writing we have to determine the structure of our essay, what's in the introduction, the main body and the end
60	0:05:26	Chris	Did you read the assignment already
75	0:06:10	Chris	[Accesses text editor]
77	0:06:25	Dan	[Role negotiation: both generate]
89	0:07:01	Chris	[Hands over control]
101	0:07:27	Dan	Important in the discussion is is that we write a catchy introduction that attracts to read this
103	0:07:56	Chris	[Role negotiation: organize]
111	0:08:38	Dan	So we'll go read articles first
114	0:09:06	Dan	We both have annulment and dump-prices, the others are different
116	0:13:16	Dan	[Role negotiation: idea generation/evaluative]
133	0:14:50	Dan	Sorry, I mis-clicked, I wanted to generate ideas. You should not only evaluate my ideas but also self-read your articles and come up with interesting things.

appropriate sentence openers (write/revise), which are creatively used by the partners to develop the argument. The manner in which the argument develops shows a mix of personal detachment (use of normative comments as in "we should," and the use of "we" in general, and occasionally involvement indicated with "I" (249, 254). The two contributions showing involvement express the different positions that the partners adhere to. The use of personal pronouns is incorporated into the sentence openers, but their detachment seems to also occur voluntarily (256, 257), showing a preference for this detached style of interaction (that could be inspired by the sentence-openers style of interaction).

Episode 4. Dan breaks away from the argument, suggesting a role change to "organize," after initiating that, suggesting they should write their ideas in the text (not in the chat). After this, Dan starts contributing again. Chris, in the chat mentions the idea of "we're flying a good airliner that also sees absolutely no danger." This develops in an inside joke, choosing

a name (the acronym AEAE) of one of their classmates for the airliner. Chris then asks for a turn to write, incorporating his idea in the text and finishing the part of the text that they discussed. They now reach a compromise on how to mention the distances between Iraqi launch sites and Turkish holiday resorts. Dan here again is a dominant factor in the direction the collaborative effort is taking. This dominance is, however, not affecting the content related interaction. Illustrative in this respect is that Dan's suggestion to take the "reliable KLM" instead of AEAE airlines apparently doesn't make it to the text, even when she has text control herself.

This episode shows a lot of socially positive behavior (tension release and agreeing), which is not distractive from their content-focus, but rather is integrated within the task functional behavior they're engaged in. Taking some distance from their earlier discussion, and releasing the (built up) tension seems to resolve their differences. Their focus apparently is shared, both contributing to the same paragraph and commenting on each other.

TABLE 4. THIRD EPISODE FOR DAN AND CHRIS

<i>Line</i>	<i>Time</i>	<i>Partner</i>	<i>Contribution</i>
196	0:25:09	Chris	[Accesses text editor]
211	0:25:39	Dan	[Hands over control]
216	0:25:54	Chris	[Accesses text editor]
221	0:26:46	Chris	[Accesses text editor]
224	0:26:57	Dan	[Role negotiation: organize]
229	0:29:05	Dan	I still miss recent info about Iraq and Turkey, an explanation of why it would still be safe to go on holiday
234	0:31:02	Dan	We should not give a list of which seaside resorts are safe and not safe, we have to give the idea that everything is safe
238	0:32:11	Dan	[Role negotiation: produce/revise]
240	0:32:21	Chris	[Accesses text editor]
242	0:33:11	Chris	[Accesses text editor]
243	0:33:11	Dan	You go now, just type here what you would normally do in the yellow window, that works reasonably well
247	0:34:24	Chris	Can I just say that Antalya lies just 800 km from Iraq and that it is the biggest Turkish seaside resort?
249	0:35:02	Chris	I think differently because we can't lie about facts
251	0:35:35	Dan	Ok, but we do have to draw in tourists
254	0:36:27	Dan	I disagree, because what I wrote was that it all lies at least 1000 km from rocket-launch installations, not from the border. Those people do not know where the launch sites are
256	0:37:02	Chris	I think differently, because we are not the CIA and we don't and nobody knows where the scud launch sites are right now
257	0:37:15	Dan	So what, we can take a gamble can we, on top, the CIA doesn't know either
259	0:37:28	Chris	[Hands over control] {Par. 1 add} First of all we want to point out that the Turkish resorts lie on a considerable distance from the Turkish border. The resorts Antalya, Bodrum and the excavated roman city of Efeze lie on respectively

And further. In the next episode the disputed part of the letter is finished. After the fourth episode there is hardly any chat interaction anymore, even then mostly limited to changing turns and prompting for finishing the task, though there is no real time constraint. The break point is visible when one of the partners has to visit the bathroom, a lack of concentration afterwards can be assumed, avoiding more intense collaboration after having resolved their main issue. Having to use the sentence openers is probably a factor also, moreover since the use of the SDS is observed to be less and less conforming to the intended use during the described episodes. The contributions to the text show a flight of

imagination in the arguments used in the text, showing (a) the victory of the "bending the rules" position to convince the reader and (b) the freedom to express their fantasy-argumentation.

SDS protocol summary. This protocol again shows a building of tension by the argumentation, which is released by the inside joke. Dan is a dominant factor in propelling the collaboration forward, (and also starting the argument) but Chris, though following this lead, shows independence in his ideas about the text. The interaction develops very slowly while interaction is kept to a minimum, though especially in the beginning this can be at-

tributed to the inclusion of the source material in the environment (long breaks in the interaction), but in general the cause should be found in the use of the SDS. The limited interaction that takes place is in accord with the sentence openers in a very broad sense by using them in a creative manner adapted to what they want to say, not necessarily to the role they are assigned. Little development of the relation between the partners is perceived. First of all, it is visible that in the beginning this relation is quite positive already. The dominance of Dan does not show up as problematic, probably because this only concerns the progress through the task. All this leads to the perception of this collaboration as reasonably professional and stable. A shared focus in the interaction shows up through reading the source materials provided, (individually but at the same time) after an initial difficult start (getting used to the SDS). This positive picture doesn't account for the inside joke that comes after the argument that was developed, this shows that tension release was perceived as necessary after the argumentative exchange.

The impact of the SDS: a comparison

The above interpretations of the two logs indicate two different work-relationships: the first dyad needed to develop a socially secure base first, while the second dyad seems to take a more hands-on approach, while showing signs of an existing positive relationship. While the first dyad was matched on their performance in creating a diagram (additionally the teacher had indicated incompatible pupils so these were not matched), a free choice of the partner, as was implemented for the second protocol, seems a better option, preventing problems in the staging of argumentative interaction.

The free choice versus assigned partner explanation can be complemented with other reasons for the difference in smoothness of the collaboration such as the inclusion of the source material in the electronic environment, which resulted in a shared focus, and of course the use of the SDS. The SDS dyad shows remarkably less contributions (probably due to a higher cost of initiation⁸), limiting interaction to what would be necessary, making contributions that are made more important and to the point. Because of the lack of superfluous interaction, it would be easier to maintain a shared focus, where the first dyad seems to have problems in reaching a shared agenda. In the use of the SDS two related aspects are noteworthy: the use of role-change in the SDS to explicitly shift focus in order

to create distance from the argument, and the implicit and fluent change of roles without actually changing roles in the SDS. The pre-defined roles seem to be too rigid. The dyad thus shows flexible use of the SDS for purposes not intended by design, sometimes ignoring the limitations of the SDS and in other occasions using it to their advantage.

Despite the SDS (and other differences), a number of noteworthy similarities between the two dyads are visible also: (a) the culmination of the collaborative effort into one real argumentation, and (b) the social repair exchanges after the argument took place, indicative of the importance of maintaining the social relation in the perception of the participants. For the first similarity, an explanation is difficult to find within the framework of the developing relation, there is no evidence of the argumentation (permanently) damaging the relation, in the first protocol the argumentation is even reflected on positively. In both cases an incident is involved that breaks the collaborative flow through the end of the lesson and a visit to the bathroom.

DISCUSSION

Two protocols in which two students worked together on a writing task were compared here. The goal of this comparison was twofold: first to explore and understand the collaborative effort from a developmental perspective, and second to assess the potential of the support offered by the SDS as a means to affect the underlying collaborative relation using the surface structure of interaction. To understand the complexities involved, a framework was developed that identified four regulatory forces that are acting upon the interaction.

In the framework, auto-regulation is the conservative force that needs to be overcome as it represents a relation that is supposedly unfit for sustained collaborative learning. Since only one argument has developed in each of the protocols analyzed, it is difficult to draw strong conclusions about the sustainability of argumentative collaborative learning interaction. The argument in the second protocol (using the support) though has a more extended lifetime, as it is continued over different episodes. Also the argument is qualitatively better when compared to the first one: it is less focused on 'who is right' and more on finding a compromise. Even though the quality of the arguments developed differs somewhat, still both of the arguments are ended with an effort to restore the relation. The apparent necessity for the observed relational repair supports the "gradual relation

view" and is an auto-regulation mechanism that indicates that both dyads are functioning within the transmission scenario. (The necessity to repair also supports the assumption that argumentation influences the relation between the collaborative partners.)

Even though both efforts bear transmission scenario characteristics, the emergence of the arguments has evolved in quite different ways. In the first protocol the identified event critical that opens up the collaboration is characterized by mutual regulation. The use of communicative silence as shown in this event is probably one of the most powerful implicit strategies to elicit such regulation in natural language. The development towards this critical incident that restored the symmetry in the relation is characterized by auto-regulation, visible in the continuous effort to build a positive relation. Contrastingly, and given the somewhat distorted interaction via the sentence openers, in the second protocol the argument develops quite natural. The distorted interaction could be the key here, since it appears to be very difficult to interpret relational aspects from such interaction. The SDS as a regulation device here seems quite effective in blocking auto-regulation and mutual regulation mechanisms. The SDS does not replace these mechanisms with its inner regulation design, but rather masks normal regulation mechanisms; in this respect the SDS as it was implemented should be considered a failure. An important factor, considering the absence of the possibility to develop the relation in the collaborative process, is that a positive relation needs to be achieved in advance. Further analysis of more SDS protocols could provide more definitive answers here, as quality of the existing relation will undoubtedly vary, even while partners are chosen.

In all, auto-regulation proves to be quite resistant in natural chat interaction. Within the transmission culture displayed in the case, auto-regulatory forces seem not very supportive of sustained argumentative interaction. Even in the structured chat, in which the argumentation might be considered as more sustained, argumentation elicits the same repair auto-regulation mechanism. Together with the relative absence of auto-regulation, caused by the sentence-openers, it can be argued that argumentation has a strong effect on the relation between dyads that are not professional collaborators. It is not intended to imply that auto-regulation is negative by definition; the mutual regulation incident of the first dyad is an example to the contrary, the advantages of the ability to consciously create the right conditions are obvious though.

The noticeable absentee in the regulation quartet is self-regulation. This kind of regulation is not explicitly visible in the dialogs presented here, since the (in origin) cognitive processes are never shared in interaction, but are acted on, leaving traces of what might be self-regulation. The framework gives a suggestion that this kind of interaction would be too costly to bring up within the restraints of the culture created between the dyads. Acting on private self-regulation proves not very effective against auto-regulatory processes. Especially the first dyad could have benefited from a better coordination of their efforts since their efforts are initially directed by different agenda's. For the second dyad three factors converge resulting in the absence of similar problems: (a) task-regulative mechanisms elicited by the inclusion of the source-materials in the electronic environment have resulted in a shared agenda almost from the onset of their effort, (b) the relation in which Dan dictates the progress through the task, taking on a leadership role, and (c) the SDS, that contributes by blocking social-relational development and consequently masks the dualism of maintaining a collaborative relation and developing learning interaction that is inherent to the studio scenario.

This paper has presented a methodology in order to analyze and explain the occurrence of learning interaction that limits itself to data derived from the observable interaction. The assumptions that are made with regard to the relation as an underlying and explanatory factor are illustrated and confirmed in the two protocols, showing the relevance of the framework. The framework is able to show the complex effects of support in an electronic learning environment and of other affordances in the environment (the source materials). The Achilles heel in the methodology used here is the interpretive nature of the analysis, which makes it unsuitable for dynamic support that could facilitate collaboration (as in intelligent diagnostic feedback-agents). The method would also be susceptible to bias in larger-scale protocol analysis. Both objections suggest finding standardized indicators that signify the state of the relation between partners. The small-scale analysis provided here gives hints and examples of important mechanisms in the development of collaborative learning interaction, and as such can inspire the design of new (supportive) communication interfaces. Aiming at larger scale comparative research though, further work is needed on standardization of indicators for the collaborative relation.

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