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# CARTE: An Observation Station to Regulate Activity in a Learning Context

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## Chapter 13

# CARTE: An Observation Station to Regulate Activity in a Learning Context

## Experiments in a Practical Class

Christophe Courtin

**Abstract** This chapter discusses the introduction of a new concept called “regulation” into a use model, which is part of a theoretical observation model called trace-based system (TBS). This concept defines a retroaction mechanism in an observation station. We present the results of experiments, in a learning context, with a prototype observation station called Collection, activity Analysis and Regulation based on Traces Enriched (CARTE).

### 13.1 Introduction

In this chapter, we present in greater detail a prototype of the observation system Collection, activity Analysis and Regulation based on Traces Enriched (CARTE) designed in our laboratory (Courtin, 2008) and especially the feasibility of a regulation mechanism, which is based on an observation instrumentation.

An observation station is a system based on a theoretical observation model that provides observers (e.g., teachers, learners, and experts) with observation services. We present a prototype which is coupled with collaborative learning software tools that enable participants to communicate with each other, to organize the group work, and to produce content collectively. We use such a system to keep track of learning activities in order to provide observers (e.g., learners, teachers, and experts) with information which helps participants in their own practice.

The final research question is how may regulation influence the learning process to take into account the social dimension? However, it is worth noting that our

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46 professional practice as teachers allows us to manage instrumented collective learning  
47 situations (ICLS), but it is advisable to be cautious about the semantic value  
48 of the results obtained by a system of observation of corresponding activities.  
49 Therefore, we will focus on computing aspects without forgetting the final objectives  
50 which are centered essentially on computing environment uses in a collective  
51 learning context. In other words, we attempt to evaluate the feasibility of our regulation  
52 mechanism, implemented in the prototype of the CARTE observation station,  
53 based on the theoretical model called trace-based system (TBS) described below.  
54 The evolution of this work will consist of evaluating how relevant this regulation is  
55 to support the social dimension in collaborative learning situations.

56 In this chapter, we first restate briefly the concepts of the theoretical observation  
57 model, which underlines the CARTE observation station model, and we shall  
58 attempt to find answers to the activity regulation problem with the help of retroaction.  
59 From this, we describe the corresponding working process with the architecture  
60 of the CARTE system. Finally, we present experiments which highlight the feasibility  
61 of a regulation mechanism in an observation station with the technical results of  
62 the CARTE prototype. We compare the last experiment to a previous one that was  
63 similar, but without the retroaction mechanism, in order to evaluate the benefits of  
64 regulation in collaborative learning activities.

## 67 13.2 Traces

69 This chapter provides a computing point of view about the concept of regulation  
70 in instrumented collective learning situations (ICLS), which widely covers other  
71 scientific fields, especially those in human sciences. We have introduced the term  
72 “regulation” (Martel et al., 2004) to represent all mechanisms that enable participants  
73 to organize themselves in a shared environment. The objectives of the  
74 regulation are to ensure social control (i.e., respect of social rules such as not  
75 talking to other participants) and to fit the activities to the pedagogical objectives  
76 according to a specific context (e.g., suggesting new exercises to students having  
77 difficulty). We propose a more precise definition of regulation in the following  
78 part.

79 We define an instrumented collective learning situation (ICLS) such as a traditional  
80 collective learning situation (i.e., in situ and in real time, such as a classroom)  
81 supported by a computing system which enables participants to communicate with  
82 each other, to coordinate their own activities, to produce content, and to regulate  
83 this situation as explained above. In our research work, we use the computing  
84 device to obtain clues about the learning context. From this, we chose to set up  
85 a specific instrumentation based on the computing events in order to obtain more  
86 elaborate traces (than the log system) of the participants’ learning activities. From  
87 the point of view of a human observer (e.g., a teacher), the final traces, that is to  
88 say those with an abstraction level close to that of the human observer, are called  
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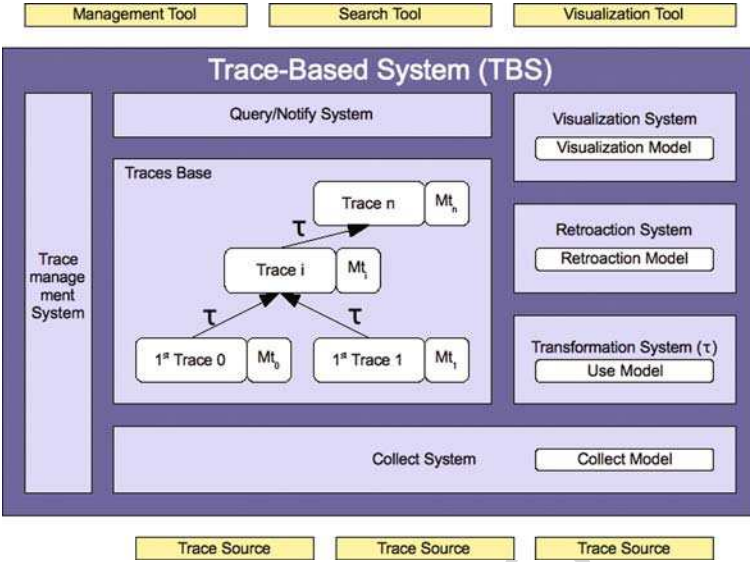
## 13 CARTE: An Observation Station to Regulate Activity in a Learning Context

91 indicators (i.e., they determine success or failure in an exercise). These indicators  
 92 enable the description of actions as they are defined by the observer him/herself. The  
 93 instrumentation technique we use is equivalent to the log system technique, except  
 94 for the fact that it takes place at the level of the software tools themselves and close  
 95 to their use model.

96 We would accept the idea that going from a traditional to an instrumented situa-  
 97 tion would benefit all the participants if the latter maintained the activities' human  
 98 dimension. It is worth noting that computing environments' techno-centered design,  
 99 which is too widely spread (Rabardel, 1995), limits use observation. The difficulty  
 100 is increased by the singular nature of the use for which a model cannot be antici-  
 101 pated. With that in mind, we maintain that it is essential to involve interactants very  
 102 early in activity analysis. This involvement occurs in the observation system design  
 103 stage and thus in that of corresponding models as explained below.

104 We observe mediated situations with the help of organized knowledge which  
 105 stems from computing environment instrumentation. The choice of instrumenta-  
 106 tion for observation is based on the idea that observation objectives are predefined  
 107 by the observer him/herself (teacher, sociologist, ergonomist, etc.) (Carron, Marty,  
 108 Heraud, & France, 2005). We then define the concept of "observed," which repre-  
 109 sents data relative to an activity observation. An activity trace, which is built from  
 110 a use model, is composed of time-situated "observed" sequences. The use model  
 111 supplies the necessary semantics to interpret the elements that compose the activity  
 112 trace. The association between a trace and the corresponding use model (Settouti,  
 113 Prié, Mille, & Marty, 2006) is termed MTrace. In order to interpret the MTrace, the  
 114 human observer has to participate in the definition of the semantics of the use model  
 115 elements.

116 We have placed traces at the heart of the theoretical observation model called  
 117 TBS, presented in Fig. 13.1, to the definition to which we have contributed with  
 118 other actors in the Technology Enhanced Learning and Teaching (TELT) field  
 119 (Settouti, Prié, Mille, & Marty, 2006). We add a retroaction module to this model  
 120 that we will describe in the next section. We propose a generic trace structure, pre-  
 121 sented in Fig. 13.2, in order to take into account the various trace sources (logs,  
 122 snapshots, annotations, etc.). Common elements among all these sources (e.g.,  
 123 description) define the meta-data and specific elements of each source (e.g., a *page*  
 124 in a text editor, a *table* in a structured chat room) define optional parameters. The  
 125 observer defines these parameters' semantics in the use model. As specified above,  
 126 we have chosen to collect traces by means of instrumentation of the computing  
 127 environment's tools. We introduce two types of templates: signals and sequences  
 128 (see Fig. 13.2). A signal generally represents basic information corresponding to  
 129 an elementary action on software tools (e.g., saving a page). A sequence repre-  
 130 sents enriched information, which makes sense for an observer and which stems  
 131 from composite actions represented by signals or even by other previously created  
 132 sequences (e.g., *edit\_page* + *save\_page* = edition). We distinguish several levels for  
 133 sequences according to how they are composed: signals and/or sequences of level  $n$   
 134 (Courtin & Talbot, 2007).



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Fig. 13.1 Trace-based system (TBS)

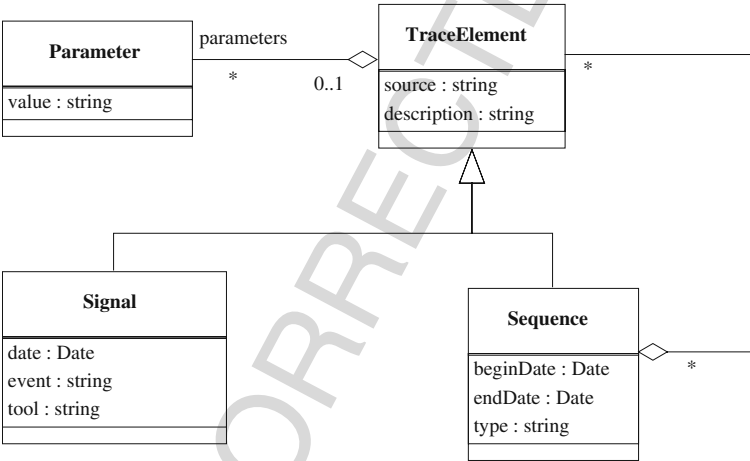


Fig. 13.2 Trace structure

### 13.3 Retroaction and Regulation

The introduction of regulation concerns taking into account a fourth dimension in the classical clover model (collaborative work model), which is divided into three spaces: communication, coordination, and production (Ellis & Wainer, 1994). A fourth space entitled “regulation,” which is orthogonal to the other three spaces,

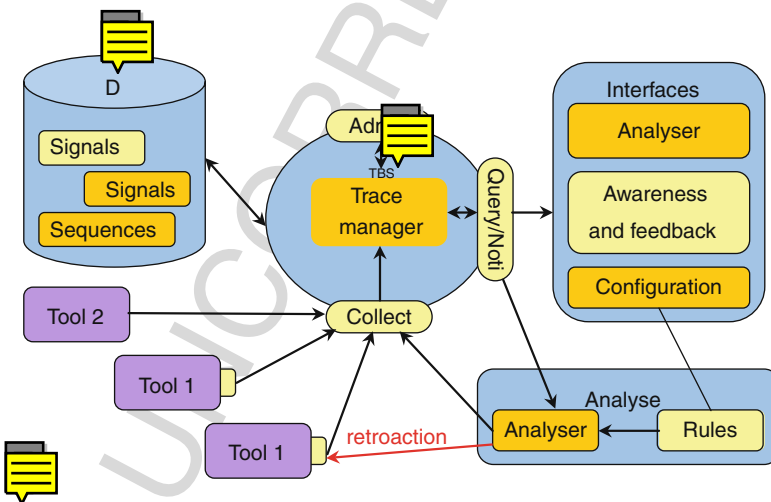
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181 is added to this model in order to take into account the activities' social dimension  
 182 (Chabert, Marty, Caron, Vignollet, & Ferraris, 2005). Regulation is a very broad  
 183 concept and it is necessary to define it in this chapter before presenting our research  
 184 work. We consider all the mechanisms for activity configuration in the computing  
 185 environment to ensure coherence between work in progress and activity objectives  
 186 (e.g., workgroup management during the activity, modification of the choice of  
 187 proposed exercises according to the situation, etc.) included in regulation.

188 The CARTE observation station we have produced matches the theoretical obser-  
 189 vation model specification, presented in Fig. 13.1, where a use model is associated  
 190 to traces. MTraces thus created may be combined by means of transformations ( $\tau$ )  
 191 in an analysis tool to produce higher abstraction level MTraces, or language level  
 192 ones, in order to help a human observer to interpret activities in a given applica-  
 193 tion domain. Therefore, our application context constrains us greatly. Indeed, users are  
 194 not involved in the design of the generic software tools which compose the com-  
 195 puting environment used for their activities. This constraint hinders use analysis  
 196 significantly. We get around it by involving the observer in computing environment  
 197 use modeling. The resulting model, built by the observer, defines the software tools'  
 198 working process without having to modify them. This approach's originality comes  
 199 from the independence of the various use models and the software tools and their  
 200 adaptability to match the various observation objectives. In other words, it is a matter  
 201 of adapting a generic tool to a specific use by modifying the working process from  
 202 traces, without modifying the tool itself. These different use models enable one to  
 203 specify social rules (e.g., forbidding unauthorized intrusion in a chat-room discus-  
 204 sion), which imply different uses that from the user's point of view are interesting  
 205 for his/her activity.

206 The analyzer tool we have associated to the CARTE observation station, of  
 207 which the working process is described in Fig. 13.3, provides "awareness" and/or  
 208



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Fig. 13.3 CARTE architecture

226 “retroaction” type traces. In the first case, the observer receives information rela-  
227 tive to “observeds” described with the use model. By interpreting this information,  
228 the user/observer (teacher, student, etc.) will be able to act on the computing envi-  
229 ronment to move the activity toward predefined objectives. In the second case, the  
230 traces trigger the execution of actions on the tools in order to facilitate their use (e.g.,  
231 task linking) or even to enrich their working process (e.g., automatically warning a  
232 user of the modification of a document that concerns him/her) without adding new  
233 functionalities.

234 In this subsection, we describe the principle of the retroaction mechanism used  
235 for the regulation of collaborative learning activity. When the observation station is  
236 started up, a base of rules (with XML format) dedicated to the regulation is loaded.  
237 The analyzer is thus ready to receive signals either collected by means of the collect  
238 Application Programming Interface (API) (e.g., the *save a page* action) or produced  
239 by the analyzer itself (e.g., the *beginning of a co-writing* action). The left-hand part  
240 of the rules that represent the specification of the use model is based on the use of  
241 operators of logic (AND, OR, NOT), of temporal relation (THEN), and of priority  
242 (brackets). Each time a signal is received, we verify whether it contributes to the  
243 condition of one or several rules. When the condition of a regulation rule is com-  
244 plete, the latter produces a sequence of actions which will be carried out on tools by  
245 means of the retroaction API (containing all the predefined retroaction methods).

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### 250 ***13.3.1 Use Model to Support Regulation***

251

252 We have seen previously that, from our point of view, the reading of traces cor-  
253 responded to the expected interpretation, which was anticipated by the observer’s  
254 involvement during the definition stage of the use model of the learning software  
255 tools. In their first version, the use models were represented by a set of rules that pro-  
256 duced templates (signals or sequences), providing awareness-type information and  
AQ5 257 thus allowing the users to operate explicitly on the tools (Courtin & Talbot, 2006).  
258 We have proposed an evolution of the model by integrating retroaction execution in  
259 the rules in order to operate directly on the learning software tools.

260 We have considered the postulate that the concept of regulation covers all the  
261 mechanisms that ensure social control and that adapt the learning activities to  
262 the pedagogical objectives according to the context. Furthermore, as far as our  
263 experiments were concerned, the teacher had integrated the collaborative dimen-  
264 sion (exchanges within pairs) into his/her pedagogical objectives. The objectives  
265 suppose a strong involvement of the learner in the group work mediated by the learn-  
266 ing software tools. Below, we will attempt to highlight the effects of the increase  
267 in coupling between these tools on the participants’ behavior. In other words, we  
268 wish to be able to appreciate the effects of the retroaction mechanisms and thus  
269 appreciate the increase in interactions on participants’ involvement in the instru-  
270 mented collaborative learning situation (ICLS).

## 13.4 Experiments

271  
272  
273 We have used an experimental approach to assess the CARTE observation station  
274 architecture and especially the regulation (R) mechanism. Furthermore, we agree  
AQ6 275 with Mille, Caplat, and Philippon (2006) that user actions depend on reactions to  
276 the environment in a given activity context. The experiments we present in this  
277 chapter complete those described by Courtin and Talbot (2006), with a new type  
278 of use model featuring a retroaction mechanism. We restate briefly the context of  
279 experiments: the previous one without regulation and the last one with regulation.  
280 Both experiments were carried out during a practical class in an English course  
281 (foreign language) with students at the university. The students, in pairs, were sup-  
282 posed to define a set of situated English words by means of a specific collaborative  
283 text editor (multilingual dictionary). They communicated in pairs via a specific chat  
284 room to organize their work to their liking. The teacher was using the same produc-  
285 tion tool to check students' definitions and the same communication tool to answer  
286 students' questions. Furthermore, the teacher coordinated the groups by means of  
287 a group structuration tool and everyone visualizes the actions with the awareness  
288 tool. The CARTE observation station may provide participants/observers with these  
289 observation tools.

290 Our experiments consist in setting up a computer-based collaborative learning  
291 session (Talbot & Courtin, 2008). From a pedagogical point of view, a collabor-  
292 ative learning activity is one that requires mutual learner involvement and which  
293 implies educative intentions that aim to assist or to facilitate the learning pro-  
294 cess. The system is composed of the following: a production tool called Jibiki  
295 (a specific collaborative text editor to create multilingual dictionaries, created for  
296 a research project in linguistics, whose working depends on trace exploitation,  
AQ8 297 Mangeot & Chalvin, 2006), a communication tool called CoffeeRoom (a chat room  
298 in which communication spaces are represented by tables), a group structuration  
299 tool, an activity monitoring tool (awareness), and the activity trace observation  
300 station CARTE.

301 As the activity scenario is very simple, it is not necessary to specify it with a  
302 scripting tool. The activity is carried out as follows:

303 Preliminary phase

- 304  
305
- 306 ● The teacher generates groups thanks to the group structuration tool.
  - 307 ● The teacher distributes the subjects with the words that have to be defined.

308 Work phase

- 309 ● The students are free to organize their work in pairs with the CoffeeRoom.
  - 310 ● The students define the words with the Jibiki and submit them to the teacher.
  - 311 ● The teacher verifies the definitions, annotates them, or validates them directly.
  - 312 ● Sometimes the students ask the teacher for help.
- 313

314 The work is finished when the class is over or when all the definitions have been  
315 completed. The main objectives of our experiments are



- 316 ● to inform about other participants' actions to which an interactant is subscribed  
317 (e.g., partner actions in a pair),
- 318 ● to enrich the functionalities without modifying the software tools (e.g., sending  
319 an e-mail automatically after having recognized a specific action or asking for  
320 help),
- 321 ● to set controls to ensure that the social rules necessary for the learning session  
322 to take place in the right way are respected (e.g., forbidding students to change  
323 tables in the CoffeeRoom), and
- 324 ● to simplify the carrying out of the operations by automating certain tasks (e.g.,  
325 automating the configuration of the learners' tools from the definition of the pairs  
326 by the teacher).

327

328 It should be noted that the above-mentioned aspects deal essentially with general  
329 group activity regulation (social rules) and not directly with the pedagogical activity  
330 itself, for example, to modify the way the collaborative learning session proceeds  
331 according to educative activities that are carried out by the students (nature and  
332 tempo). However, we think that some actions thus regulated improve interactions  
333 with the computing environment and can have an influence on learning conditions.  
334 It is what we attempt to show with the experiments results.

335

336

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### 338 **13.5 Description of the Software Learning Tools**

339

340 We consider the postulate that an instrumented collaborative learning situation  
341 (ICLS) has to fit the specification of a groupware model, which takes into account  
342 all aspects of the collaborative work. We thus use as a base the previously presented  
343 augmented clover model, namely the classical model with a regulation space. The  
344 experiments that we have described have been carried out by means of learning soft-  
345 ware tools, which are initially designed for independent uses, that is to say which  
346 do not support intertool collaborative activities in real time. The adaptation of these  
347 tools, which are able to interact with each other and offer functionalities that are  
348 adapted to the collaborative learning situation, has been made possible thanks to  
349 the use of the traces they produce. Taking into account the objectives of our experi-  
350 ments, described above, we have thus selected learning software tools which cover  
351 the various spaces of the augmented clover model.

352 The production tool used is the Jibiki editor (see Fig. 13.4), which allows the  
353 creation of multilingual corpuses by means of a Web client. In this tool, each par-  
354 ticipant is registered with a casual role, that is to say a role that is associated with  
355 a set of possible actions (e.g., setting a new definition, validating a definition, and  
356 administrating the corpus). Because Jibiki is a Web client, we have chosen to use  
357 HTTP requests to retroact from the observation station and thus from the retroaction  
358 module. An API (application programming interface) has thus been created to pro-  
359 cess the retroaction requests in a generic way. A request is associated with a generic  
360 method which receives the following parameters:

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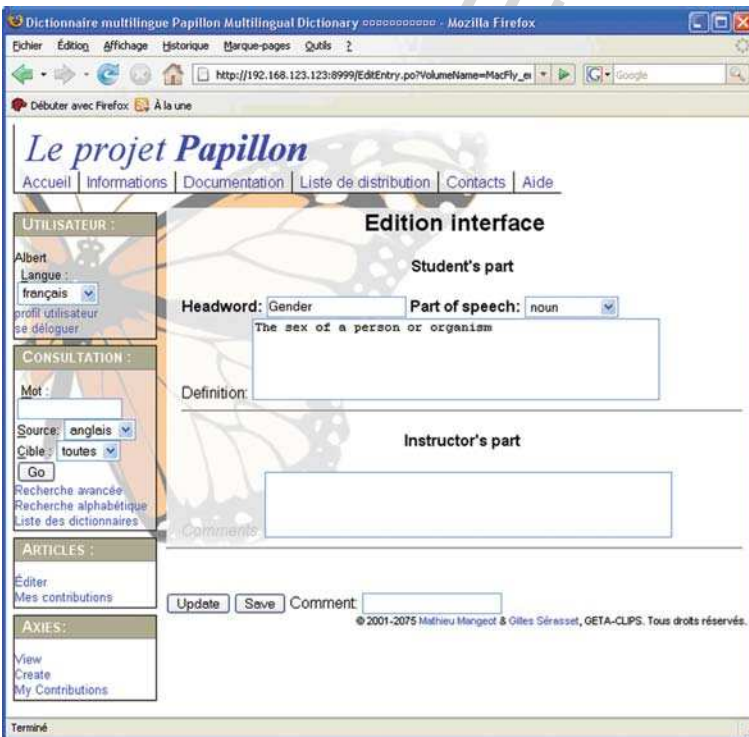
- ActionType which represents the action to be triggered (the actions are located by means of constants).
- ParametersList which contains all the necessary parameters so that the request is sent.

For example, disconnection corresponds to an HTTP request with the following parameters:

- Action type: Jibiki disconnection
- Jibiki address: <http://yeager.univ-savoie.fr>
- Port used by the Jibiki: 8999
- Corresponding Java method corresponding to the disconnection: LoginUser.po
- Session identifier: ;jsession=KbK4LJQ9zTQa13uAasQTcf63
- Parameter: ?Logout=yes

In the context of our experiments (see Fig. 13.4), we have instrumented the editor in order to detect the following predefined set of actions:

- The (de)connection of a user (e.g., the student Albert),
- The creation of an entry (e.g., the word “gender”),



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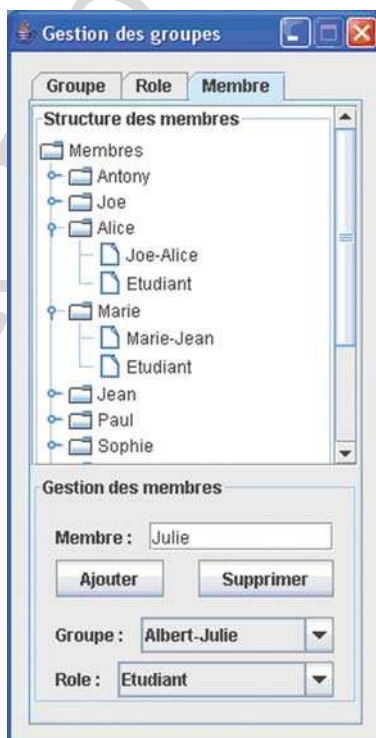
Fig. 13.4 Jibiki

- 406 • The editing of a definition (e.g., “the sex of a person or an organism”),
- 407 • The submission of a definition (to be checked by the teacher),
- 408 • The setting on standby of a definition to be corrected,
- 409 • The reviewing of a definition (to take into account the teacher’s annotations),
- 410 • The validation of a definition (when it is correct), and
- 411 • The integration of the definition in the corpus (when it is validated).

412

413 A pair management tool has been specifically implemented to match the experi-  
 414 ments’ needs (see Fig. 13.5) by respecting a strict specification, according to which  
 415 the functionalities for the collaboration are based on the use of traces. This specifi-  
 416 cation guarantees the independence of this coordination tool’s implementation with  
 417 regard to other tools, while allowing functional interdependence. In other words, the  
 418 interactions with other tools are carried out solely by the retroaction rules defined  
 419 in the analysis module of the observation station. In practice, after the teacher has  
 420 set the pairs, the traces collected by the observation station trigger rules in which

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445 **Fig. 13.5** Pair management  
 446 tool<sup>1</sup>

448 <sup>1</sup>Translation:

449 “gestion des groupes/membres” means “group/member management”

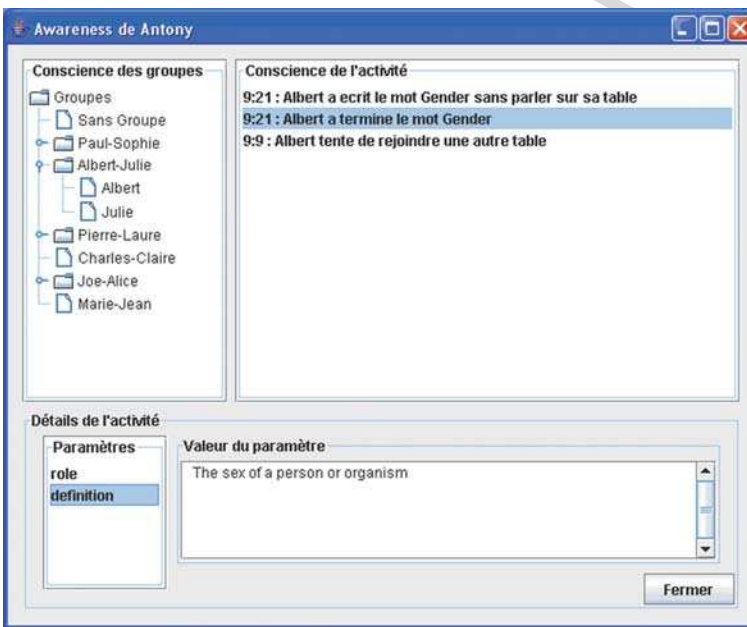
450 “ajouter/supprimer” means “add/delete”

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451 retroactions enable the creation of the corresponding tables in the CoffeeRoom. It  
 452 should be noted that with this intermediate mechanism replacing the CoffeeRoom  
 453 by another structured communication tool would not affect the implementation of  
 454 the pair management tool.

455 As has been explained above, the specification of the learning software tools  
 456 implies no modification of their code. Thus, an awareness tool (see Fig. 13.6) has  
 457 been designed to gather information relative to the context of the activity in progress  
 458 (e.g., the group structure, the name of a participant in difficulty, the action that has  
 459 just been carried out, etc.). This information stems from “observeds” defined by the  
 460 observer him/herself, with a level of interpretation very close to that of the latter.

461 The CoffeeRoom is a structured chat-room tool (the conversation spaces are  
 462 represented by tables, presented in Fig. 13.7) used for communication among partic-  
 463 ipants according to rules defined by the teacher at the beginning of the session. For  
 464 example, during the preparation of the practical class, the teacher defines the pairs by  
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487 **Fig. 13.6** Awareness tool<sup>2</sup>

489  
490 <sup>2</sup>Translation: the most recent action is at the top of the list

491 “Conscience de l’activité (des groupes)” means “(group) awareness”

492 “Sans groupe” means “without a group”

493 “Valeur du paramètre” means “parameter value”

494 9:21: Albert has written the word “gender” without talking at his table

495 9:21: Albert has finished the word “gender”

9:9: Albert is trying to join another table

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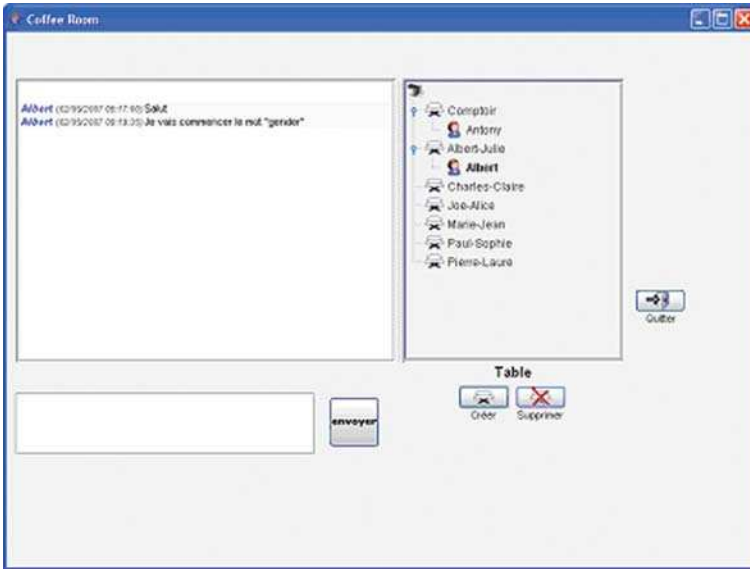


Fig. 13.7 CoffeeRoom<sup>3</sup>

means of the workgroup management tool previously presented, then enacts rules of social control by means of the observation station's rule editor. From then on, any action which breaks these social rules (e.g., Albert is attempting an unauthorized move to another table in the CoffeeRoom; see Fig. 13.6) will cause retroactions, such as sending warnings in the awareness tool (e.g., Antony, the teacher, is warned about participant Albert's attempted intrusion into another pair) or acting on the tool in which the transgression has been committed (e.g., the participant is returned to the table he/she came from). Therefore, this communication tool, when it is instrumented, has its functionalities enriched by the use of the activity traces of a group within a set of tools (taking into account part of the context).

In the context of our experiments, we have instrumented the CoffeeRoom to allow its automatic configuration from the session specification, which is carried out by the teacher (i.e., pair definition, setting-up of social rules, etc.). The retroactions thus identified are creating or deleting a table (from traces stemming from the configuration of the group management tool); connecting or disconnecting a user, adding a user to a table (according to the defined pairs); and sending a message to a table (e.g., to warn the partner automatically of the validation of an action). Following the example of the Jibiki, the CoffeeRoom has an API to carry out the aforementioned retroactions. In the same way, a generic method receives parameters such as the reference of the server, which centralizes the messages and on which

<sup>3</sup>Translation: "envoyer" means "to send"

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541 there are already the methods corresponding to the various (retro)actions. This techn-  
542 nique allows one to be both independent of the communication tool (if it contains  
543 separate discussion spaces) and to take into account the specificities of the chosen  
544 tool (here, the CoffeeRoom). The retroaction API, which is linked to the server of  
545 the CoffeeRoom, enables remote access via the Remote Method Invocation (RMI)  
546 protocol. The regulation module then has a Java interface listing all the possible  
547 retroactions which will be called up remotely at that time.

548 We have presented above an instrumentation of the various tools, which allows  
549 the analyzer to implement both types of regulation, namely human interventions  
550 from information which stems from the “observeds” (awareness) and retroactions  
551 triggered by one or several rules predefined by the observer him/herself. In both  
552 cases, the system is based on the exploitation of activity traces that are collected,  
553 then analyzed in the observation station by means of predefined use models.

### 556 13.6 Results

558 Our research objectives consist of transforming information that stems from com-  
559 puting traces in order for it to be relevant for a human observer and in testing our  
560 models’ strength. In the first experiment, the software tools used in the collabora-  
561 tive work were independent of each other. However, we were defining a use model  
562 to recognize actions performed on one or several software tools. The observation  
563 system was able to provide participants with awareness information, but it was not  
564 able to trigger actions directly on the software tools. Thus, the latter were limited  
565 to their own functionalities. We briefly reiterate below certain limitations observed  
566 during the first experiment:

- 568 • Lack of information on activity within a pair (e.g., a student is not warned about  
569 the acceptance of a definition sent by his/her partner),
- 570 • Difficulty in identifying those who need help,
- 571 • Difficulty in having the rules respected (for example, pair separation) and in  
572 taking into account pedagogical context features,
- 573 • Presence of certain repetitive tasks specific to tools (e.g., in Jibiki, the definition  
574 validation by the teacher is always followed by a corpus introduction; two actions  
575 are necessary), and
- 576 • Lack of synchronization for actions performed within different tools (e.g., group  
577 management by teacher and corresponding configuration of the CoffeeRoom).

579  
580 Therefore, it is a matter of analyzing the effects resulting from this new use model  
581 feature by means of the experiments presented below.

582 With regard to the last experiment, a computer-based study alone does not allow  
583 us to evaluate the regulation’s effects on learning quality. On the other hand, this  
584 experiment has revealed the use model’s capacity to specify the regulation actions  
585 of the activity in progress during an instrumented collaborative learning session. In

586 order to present these results, we propose to describe the retroaction mechanism and  
587 present the related effects on the learning activity. To carry out retroaction on tools,  
588 we have modified the analyzer tool (see Courtin & Talbot, 2006) to add a list of  
589 actions to perform on the right-hand part of the rules. These actions are triggered  
590 after the sequence is recognized and added to the TBS. The use model allows us to  
591 define an abstraction level between actions to be carried out and the various tools'  
592 API (application programming interface). In concrete terms, a name is associated  
593 with every action as well as parameters for which the semantics are defined at the  
594 use model level. In our case, for example, the actions on Jibiki are sent to it in an  
595 HTTP request form, whereas those dedicated to the CoffeeRoom or to the awareness  
596 tool are carried out with remote methods invocation (RMI) in Java language.

597 From a functional point of view, the use model integrating the retroaction mecha-  
598 nism implies an incoming instrumentation for the tools concerned, which completes  
599 the outgoing instrumentation that ensures the connection between the trace sources  
600 and the first trace of the collect module of the CARTE system (see Figs. 13.1 and  
601 13.3). From the point of view of the system architecture, there is no direct link  
602 between the tools; all the actions are triggered from the MTraces, which are pro-  
603 duced by the TBS. A major advantage of this level of abstraction that is the use  
604 model is that it preserves the independence of the tools which are thus interchange-  
605 able. For example, the action that consists of putting a participant back onto his/her  
606 table in the CoffeeRoom is associated with the event *join* with two parameters:  
607 the name of the discussion space (here, the table) and the user's identifier. With  
608 another communication tool, whose structure features communication spaces bear-  
609 ing different names (e.g., rooms), the rule would then be the same, which would  
610 exempt us from modifying the use model at the observer level. We also note the  
611 relevance of going through this level of abstraction, which places the trace at the  
612 heart of the system and which then guarantees the persistence of the trace of all  
613 the stages that have led to a retroaction, the latter itself generating a new trace. For  
614 example, when a participant tries to change tables (event *join* with another table  
615 name), the trace produced by this attempt triggers a rule which executes an action  
616 on the CoffeeRoom (join his/her own table) and another one on the awareness tool  
617 (notification for both the teacher and him/herself), which will generate two new  
618 traces.

619 Retroaction increases coupling between the various software tools, which tends  
620 to change the way the tools are perceived by the interactants. For example, the fact of  
621 joining the awareness tool with Jibiki, which was initially designed to do collective  
622 editing with a very low coupling, allows us to warn the pair partner about definition  
623 validation and to visualize the right version. We have noticed the analyzer tool's  
624 efficiency, which enables it to be used online during the learning sessions. The rules  
625 we have specified in these experiments enable the following:

- 626
- 627 ● To have feedback about the other participants' activities (e.g., a student is warned  
628 in the awareness tool when his/her partner has completed a definition not to do  
629 the same),
- 630 ● To change the way the tools are perceived because of the increased interactivity,

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- 631 • To automate certain tasks, in particular for the teacher (e.g., in Jibiki, with only  
632 one action, the definition validation by the teacher is automatically followed by  
633 a corpus introduction, what is an ergonomic improvement without modifying the  
634 software tool), and
- 635 • To reinforce social control at the group level (by restricting, for instance, the  
636 possibility of communication between students belonging to different groups).

637

638 The fact that retroactions are useful traces for recognizing other activities rein-  
639 forces the idea that the sequences from which they originate have to be stored in the  
640 TBS. Likewise with the traces produced by these retroactions. This illustrates the  
641 trace-centered nature of our observation system.

642 As a result, the retroaction mechanism enriches the use models by adding vir-  
643 tually new functionalities without modifying the software tools themselves. From  
644 this, we have also observed new students' behavior, like discussion after a word has  
645 been validated in order to understand the right definition. In other words, these new  
646 virtual functionalities may increase the collaboration within student pairs.

647 We can notice that through these experiments, the enrichment of interactivity, on  
648 the basis of information emanating from the context (activity in progress, difficulties  
649 encountered, etc.), gives rise to new behaviors. For these experiments, the collab-  
650 oration between participants within a pair was part of the pedagogical objectives  
651 defined by the teacher. It remains to be seen whether these new behaviors meet the  
652 expectations of the latter. The CARTE system already allows us to perceive very  
653 promising answers to this question which will be the basis of new experiments in  
654 the context of the setting up of a test-bed project (customization of the technol-  
655 ogy-enhanced learning systems [TELS] of the research cluster ISLE of the Rhône-Alpes  
656 Region, 2008–2011), dedicated to researchers in computer science, social sciences,  
657 didactics, etc. The observation station will then be able to interact with this activity's  
658 trace-centered benchmarking platform.

659 The expectations of the observers (e.g., experts, teachers, and learners) are the  
660 production of indicators, that is to say traces with a level of abstraction close to their  
661 interpretation. During the preparation of the learning session, the teacher defined  
662 explicit rules that specify the use model for the analyzer. For example, when a user  
663 writes "help" on a table, a message is sent directly to the awareness tool for the  
664 teacher's attention. This trace is then calculated from the event "send a message on  
665 a table" containing the single text message, *help*. For the teacher, it is an indicator of  
666 the type "awareness," confirming any difficulty encountered by a learner. Another  
667 example of an indicator, namely the warning message about an attempt to intrude  
668 on another table, may be interpreted by the teacher as being a test of navigation in  
669 the CoffeeRoom, or the wish to communicate with another pair, or the search for  
670 solutions elsewhere in spite of the instructions, etc. The goal of this regulation (the  
671 fact of thwarting the attempt automatically) is to introduce social control into the  
672 session to guarantee the respect of the pedagogical objectives.

673 With the experiments, it appears that the CARTE system seems to support basic  
674 regulation in ICLS. However, we have noticed some limits in the current version  
675 of the prototype to express specific actions of regulation such as the following: to



warn the teacher when a pair of students has completed  $n$  definitions in a given period of time. Indeed, iteration and time dimension are not already supported by the rules editor. In fact, we get around the iteration drawback by repeating  $n$  times the corresponding MTrace (signal or sequence). These technical drawbacks may be solved by adding a new analyzer and then by applying a new use model, working on previously generated MTraces (i.e., with the first analyzer). We plan to carry out this work for the next version of the prototype.

## 13.7 Conclusion and Perspectives

We have described an improvement of the trace-based system (TBS) to allow and take into account regulation in collaborative activities in a learning context. A prototype observation station called CARTE has been presented, and the results of the experiments carried out with students at the university have enabled us to test our models' strength and have highlighted the added value of such a trace-centered system with a retroaction mechanism.

We are currently working on how to operationalize our observation system in a project about multilingual dictionary asynchronous co-construction (Mangeot & Chalvin, 2006). An important first stage of this work consists in defining relevant indicators for this new type of analysis.

We are also thinking of enhancing pedagogical scenarios (Martel, Vignollet, Ferraris, David, & Lejeune, 2006; Talbot & Pernelle, 2003) with our activity trace models, particularly by exploiting the analyzer retroaction mechanism.

Generally speaking, we plan to work in a full-service groupware perspective. This implies orienting our work toward generic observation services for collection, analysis, awareness, retroaction, etc.

Given that the CARTE system strictly respects the specification of the theoretical model of TBS, this observation station has been selected for the study of an activity trace management platform in technology-enhanced learning systems, in order to create corpuses of reference that are open to the international community of researchers.<sup>4</sup> The goal of such corpuses is to be found at the intersection of numerous problems centred on a research object, called a trace, which derives from various sources and is able to take different forms, while respecting a specification to allow interoperability with other traces and to take into account all the specificities inherent in its use (ownership, ethics, classification, etc.). This benchmarking platform is dedicated to research in computer science, social sciences, pedagogy, didactics, etc.

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<sup>4</sup>This work in progress is part of the research cluster ISLE, project "customization of the technology-enhanced learning systems (TELS)", supported by the "Region Rhone-Alpes" in France.

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## Chapter 13

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