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Benefits and Constraints of Distributed Cognition in Foreign Language Learning: Creating a Web-based Tourist Guide for London

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Abstract

This paper uses the framework of distributed cognition to discuss benefits and constraints of technology adoption and use in social-constructive language learning scenarios. The purposes of this paper are (a) to describe how the open-ended knowledge construction and communication tools TEE (The Electronic Exercise) and EF-editor (Exercise Format Editor) can serve social-constructive language learning from a distributed cognition point of view, (b) to report how TEE and EF-editor have been used in a foreign language classroom with 25 seventh grade students for creating a Web-based tourist guide to London, and (c) to present the results of an evaluative study investigating the benefits and constraints the teacher and students experienced through this learning scenario. Finally, these results are discussed with regard to the heuristic value of distributed cognition for technology-enhanced social-constructive learning-scenarios. (Keywords: Distributed cognition, multimedia tool, social-constructive language learning, multimedia literacy.)

INTRODUCTION

Foreign language learning is crucial to students' academic and personal education. In many domains, a person's professional and individual success is related more or less to her ability to communicate at least in one if not several foreign languages. Acquiring communication skills is only possible if students develop skills in understanding *and* producing oral *and* written texts. As print is no longer the dominant media format, this includes understanding and producing language artifacts with all forms of print and electronic media. Hence, foreign language teachers should develop and implement teaching approaches integrating various ways of oral and written practice of the language to be learned.

Social-constructive learning scenarios, in which the learner has to take part in an active, creative, and socially interactive process using the language to be learned, are considered to provide a fruitful framework for designing and realizing such integrative language learning approaches (e.g., Harper, Hedberg, Wright, & Corderoy, 1996; Rueschoff & Ritter, 2001). In a social-constructivist approach of teaching, learning is promoted through collaboration—collaboration among students, and between students and teacher. As students share background knowledge and participate in the give and take of collaborative and cooperative activities, they are negotiating meaning and building knowledge.

Yet, organizing and implementing social-constructive processes effectively in

classrooms is very challenging (e.g., Brophy, 2006, 2002). If students are not used to work collaboratively, time is needed to train effective collaboration strategies. Hence, teachers must not only master subject-matter knowledge, but also knowledge on how to scaffold social interactions in small groups, namely the communication and negotiation of knowledge from different perspectives to construct and share knowledge (Kirschner & Kreijns, 2005; Slavin, 1996).

Computer-based technology provides many tools that support sharing, negotiating, and constructing knowledge. Yet, integrating computer-based technology adequately into a social-constructive learning scenario requires teachers and learners to acquire *media literacy,* that is, skills in mastering the operational, cultural and critical dimensions of accessing, recognizing, comprehending, analyzing, evaluating and communicating information in a variety of formats (e.g., print messages, audio-visual messages). According to many experts of media literacy these skills are best developed if education includes both media analysis and production (e.g., Worsnop, 1994; see also http://www.amlainfo.org/medialit.html). That is, teachers and learners should not only be consumers, but also designers of information (see also Jonassen & Reeves, 1996).

Despite the wide variety of multimedia tools, including media production into learning scenarios is very demanding and thus raises further issues for planning and implementing technology enhanced social-constructive learning scenarios. Teachers have to (a) select or develop both adequate discourse and design tasks, (b) search information resources and tools for effectively working on these tasks, (c) possess the technical skills for accessing and using these tools, and (d) possess knowledge on social-constructive approaches to learning and specific strategies for transferring this knowledge into approaches to teaching with technology. As Schwartz (2008) points out in this issue of *JRTE*, teachers often have problems to accomplish all these requirements because they do neither view technology as cognitive tools, nor understand how knowledge is actively constructed through interactions among persons, material, tools, etc. Hence, one important goal in the field of technology in teacher education should be to discuss theoretical frameworks which help teachers to adopt a cognitive and social-constructive view on technology in education.

Distributed cognition (DC) is a framework that is specifically tailored to understand interactions among persons and (technical) artifacts, tools, material or resources (Hollan, Hutchins, & Kirsh, 2000). It emphasizes the distributed nature of cognitive processes and phenomena in relation and interaction with various resources and materials, (technological) artifacts and tools, and all kinds of internal and external representations of information. The theoretical emphasis on distributed cognitive processes and phenomena is on the one side reflected in methodological approaches focusing on resources and activities, and how these activities are coordinated to pursue goals. On the other side it provides different levels or units of analysis to describe and research complex socially distributed cognitive activities (Hutchins, 1995). One can for example focus on the processes (a) of an individual interacting with an artifact, (b) of several individuals interacting with each other on the basis of their shared knowledge, (c)

of a group of individuals interacting with each other and an artifact, or (d) of an individual in coordination with a set of tools, etc.

Thus far, the DC-framework has been primarily investigated within small sociotechnical systems in which experts have to access, evaluate, and communicate information using technical tools and resources in order to accomplish specific tasks (i.e., the cockpit). Technology enhanced social-constructive learning scenarios (TecSocCon-LS), that is, social-constructive learning scenarios that use computer-based technology as tools for sharing, negotiating, and constructing knowledge, are far more complex sociotechnical systems. Furthermore, the expertise of teachers and learners in mindfully accessing and using technical tools to construct and communicate knowledge is often rather low. Yet, in TecSocCon-LS teachers and learners have also to access, evaluate, and communicate information using technical tools and resources in order to pursue their learning goals.

This paper aims at accomplishing the task of documenting in detail the actual practice of planning, implementing, and evaluating a TecSocCon-LS, in order to contribute findings to the following research questions:

a) Which functions of the open-ended software tools *The Electronic Exercise (TEE)* and the *Exercise Format Editor (EF-editor)* are elicited if one uses the DC framework to analyze and describe a TecSocCon-LS?
b) How do the teacher and the students assess the value of these functions for an effective implementation of a TecSocCon-LS?
c) Which are the values and limitations of using DC-framework as a heuristics for describing and evaluating a TecSocCon-LS?
d) Which issues for teacher education are raised if one analyses the actual practice of learning *with* technology on the basis of the distributed cognition framework.

FUNCTIONS OF THE OPEN-ENDED TOOLS TEE AND EF

According to Hollan, Hutchins, and Kirsh (2000, p. 179) "The distributed cognition theory holds that cognitive activity is constructed from both internal and external resources, and that the meanings of actions are grounded in the context of activity." As a consequence, situated human cognition can only be understood, if the context of activity (= task environment) is described with regard to (a) its structure (i.e., task goals and their subgoals, human and material units which constitute the task environment, and relations among these units), (b) the processes actors engage in, and (c) the artifacts they produce to pursue the task goals.

From a DC point of view, describing a TecSocCon-LS requires at least to detail the following aspects:

The *structure* of the social-constructive task environment with (a) its specific task goals, sub-goals, and task requirements, (b) its constituting units—here persons or actors (e.g., teacher, individual learner, small group of learners, whole class), the material and/or human resources these actors use to pursue their goals mindfully (e.g., texts, pictures, Internet resources, intranet resources, other

learners, teacher), and the technical tools which are available for pursuing the goals, and finally (c) the relations among these units;

The *processes* the participating actors engage in to pursue the task goals and subgoals. In a social-constructive learning scenario these are at least teacher activities, individual learner activities, small group activities, whole class activities, bilateral teacher-learner interactions, learner-learner interactions in small groups, teacher-small group interactions, and teacher-learner interactions within whole class activities. All these activities and interactions can be implemented in coordination with a set of technical tools and material resources, or merely with a set of material resources.

The *artifacts* the participant actors produce, which in a TecSocCon-LS can be created by the teacher, individual learners, small group of learners, and the whole class.

This DC-description of a TecSocCon-LS elicits that sharing and communicating knowledge and information, or at least the access to resources and tools, is crucial for the coordination of cognitive activities in such a complex task environment (e.g., Hutchins, 1995; Hollan et al. 2000; Schwartz, 2008). As the level of expertise of groups of learners is generally heterogeneous, maintaining and monitoring coordination within such a complex task environment is related to several barriers (cf. Bromme, Hesse, & Spada, 2005):

- Communicating knowledge in order to mutually construct meaning needs an adequate common ground (*common ground barrier*)
- Individual acquisition of knowledge in order to be able to communicate it to others is only possible if each learner has adequate prior knowledge and skills (*epistemic barrier*)
- Mutually constructing meaning or knowledge requires the pooling of all unshared knowledge (*unshared knowledge barrier*)
- Social interaction needs structure in order to guarantee effective processes of communicating and constructing knowledge (*interactive structure barrier)*
- Effective social interactions for mutually constructing knowledge are only maintained if motivational problems (e.g., free-riding, social-loafing, sucker effect) are kept as minimal as possible (*motivational barrier)*.

In the *Study 2000* project we developed and evaluated generic authoring tools which can help to overcome these barriers by serving several functions directly related to the tenets of DC (see http://studierplatz2000.tu-dresden.de): The *Study 2000* tools provide facilities for creating a common basis of Web-based learning resources which help (a) to communicate and share knowledge and information among all participants of a TecSocCon-LS, (b) to coordinate individual and group activities, and (c) to represent the processes and products resulting from these coordinated activities. These tools include:

- The s2w-compiler (Study-to-Web Compiler), an authoring tool which supports teachers and learners in integrating multiple learning materials and media into an interface which provides direct and efficient access to

all materials and media (for a detailed description see Narciss, Proske, & Körndle, 2007; http://studierplatz2000.tu-dresden.de/s2w).

- The Electronic Exercise (TEE), an authoring tool for building well-structured, computer-based learning environments was developed on the basis of the theory of knowledge structures (Albert & Lukas, 1999). The knowledge is broken up into small units (elements, building stones, nodes) and every unit may include different material such as text, links, pictures, or graphics. The units are represented in nodes, which can be linked either (a) by the surmise relation, determining the knowledge structure of the given domain in the sense of a hierarchical order indicating which nodes should be mastered before other nodes can be dealt with, or (b) by various kinds of semantic relations which create a knowledge map, similar to common mind maps or concept maps (for more details see Krausse & Koerndle, 2003; http://studierplatz2000.tu-dresden.de/tee).
- The EF-editor (Exercise Format-editor), an authoring tool, which facilitates the construction and implementation of interactive learning tasks (for a detailed description see Proske, Körndle, & Narciss, 2004 http://studierplatz2000.tu-dresden.de/efb). In contrast to test exercises, interactive learning tasks are solved interactively with the additional aid of multiple-try strategies and informative tutoring feedback if required (Narciss, 2006; Narciss & Huth, 2004).

TEE and the *EF-editor* were used in this work and their functions will thus be described in more detail in the following sections.

TEE: The Electronic Exercise

TEE is an open-ended knowledge creation or representation tool. It facilitates the representation and integration of information or artifacts of various formats into a multimedia learning environment (Figure 1, p. 286). *TEE*-learning environments are adaptable, because they can be easily modified.

The main part of the *TEE*-interface consists of the working space, in which the learning material of various formats, the exercises or links providing access to various resources (e.g., dictionaries, guided tours, quiz items) are displayed. The frame at the left side presents a diagram of the knowledge map, and the access to exercises and to the detailed knowledge map. The knowledge map can be used for navigation—a mouse click at a node opens its learning material and displays exercises. Thus, it works as a two-dimensional table of contents. To facilitate orientation the small diagram always indicates the position of the currently opened node.

TEE is implemented by dynamic HTML and can be used with an Internet browser of at least 4th generation. Due to its client side dynamic *TEE* can be used online and offline. Personal performance data can be stored on the computer (cookie) on the Internet (on a server) or as a file on disk (for more technical details see http://studierplatz2000.tu-dresden.de/tee).

To create a multimedia learning environment with TEE, an author has first to divide the selected knowledge domain or task environment into units which

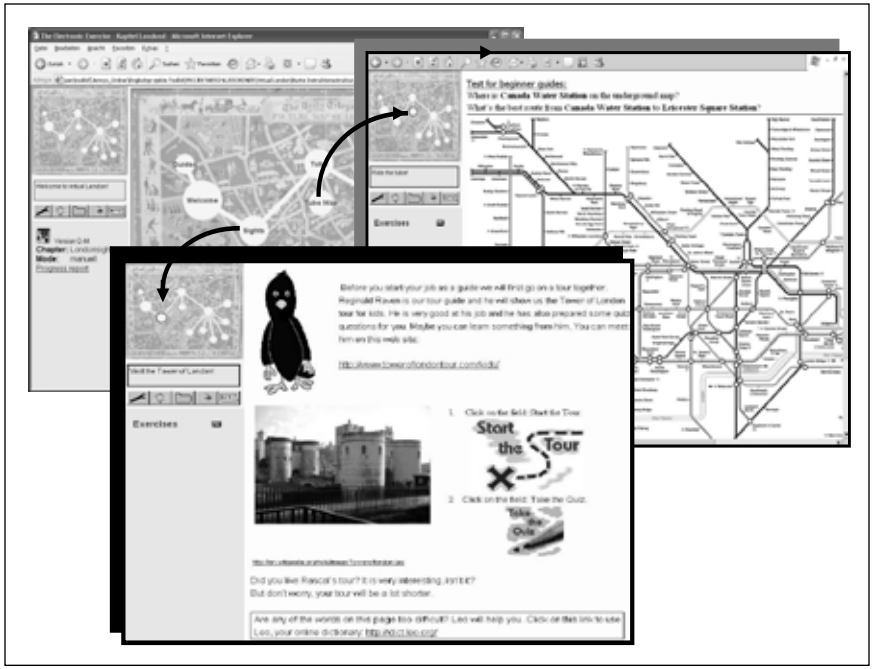

Figure 1: Screenshots of the TEE-Interface—background left: large diagram providing a overview of the knowledge map; background right: example of a learning task; front left: TEE-interface with working space, small knowledge map indicating the actually opened node.

can be represented in nodes, and define the relations among these nodes to organize the nodes in a structured knowledge map. The next step is to create or select the learning materials and resources, which should be included into each node, and transform them into HTML files. This can be done with any Web site editor/generator. Furthermore, exercises (e.g., test items, interactive learning tasks) have to be designed using the EF-editor, which compiles the exercises into HTML files that can be directly integrated by TEE. The created or selected HTML-materials, resources, and EF-exercises are then entered into a TEE-table, which requires labeling each HTML file, assigning it to a specific node, indicating the relations among the nodes and writing a comment (Figure 2). If this TEE-table is completed, the TEE-machine can be used to compile all materials, resources, and exercises into a TEE-learning environment. The use of TEE as an authoring tool is quiet simple, because knowledge in programming is not needed.

As *TEE* requires the authors to structure units of information into related nodes it might contribute to represent knowledge externally in a precisely organized manner. According to Suthers (2005) such external representational artifacts are useful for off-loading work. Furthermore, the act of expressing one's ideas or knowledge in an external representation helps to share and communicate this knowledge.

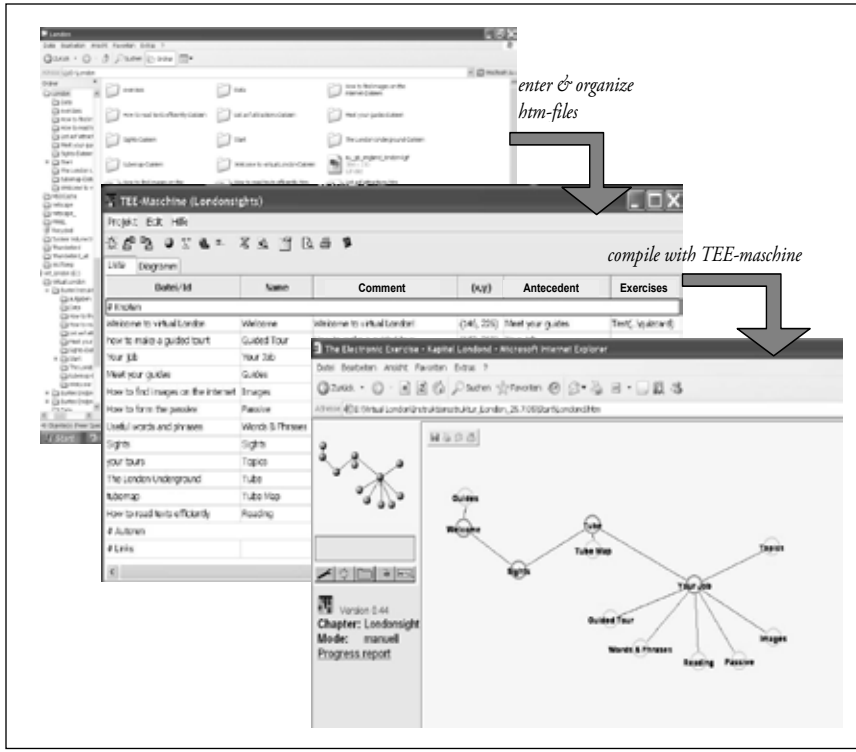

Figure 2: Screenshots of the TEE-machine illustrating core steps of creating a TEE-environment.

EF-Editor

Exercises are of particular interest for effective teaching and learning because they can initiate and support students' active and intensive information processing. Exercises in a TecSocCon-LS may serve (a) to assess and activate prior knowledge, (b) to monitor and scaffold the learning process, and (c) to assess the acquired knowledge. However, to fulfill these functions, the complexity of the exercises should be tailored to the complexity of the learning scenario. In the context of a TecSocCon-LS this means that there must be not only simple exercises, but also complex exercises. Yet, the systematic construction of complex multimedia exercises is a challenging task.

In order to help instructors to master these challenges, we have developed a format called *Exercise Format* (*EF*) which is a plain text format describing the abstract data of an exercise and providing the possibility to save the data within a file. Via this format the exercises can be applied in different multimedia settings. To facilitate the editing of *EF*-files we have designed a tool called *Exercise Format Editor* (*EF-editor*). The development of the *EF-editor* is based on psychological findings on cognitive task analysis and on self-regulated learning with multimedia learning environments (for a detailed description see Proske, Körndle, & Narciss, 2004).

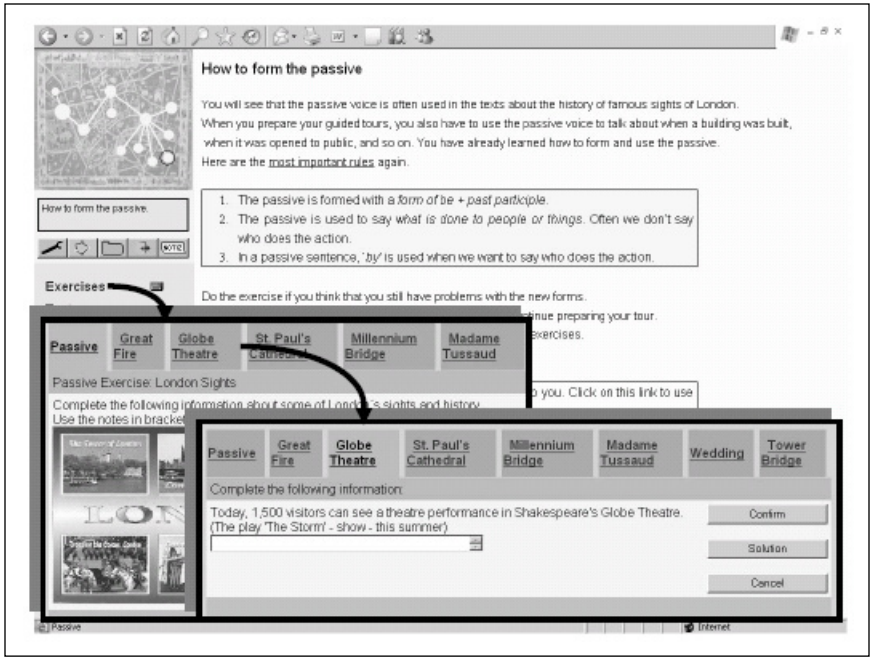

Figure 3: Screenshots of the Passive-Node and of EF-exercises on how to use passive integrated in a TEE-learning environment.

The user interface of the EF-editor consists of three areas: an editor, a browser preview and an explorer for navigation within the EF-files. The EF-editor provides facilities for creating a large variety of item and response formats. These formats span from simple short answer and multiple-choice items across several types of completion texts to complex types of matching tasks. Furthermore, it is possible to integrate various types of media and material into an exercise (e.g., www-links, simulations, audio-visual artifacts). Material that can be interpreted by a current Web browser is also able to be used for EF-exercises. The EF-editor also allows using different templates that encourage the constructor to generate exercises in several appearances and/or languages (for a detailed documentation of all the EF-functionalities see http://www.studierplatz2000.tu-dresden.de/english/ef). EF-exercises can be easily integrated into a TEE-learning environment (Figure 3).

METHODOLOGY

Participants

Teacher. The teacher, Sonja Hannemann, had about one and a half years of classroom experience, and was just finishing her second inservice year. At the end of this second year she had to pass the second national exam for teachers (2. Staatsexamen für das Lehramt an Gymnasien), which consists in part of preparing, implementing and documenting in detail a pedagogically founded teaching unit (i.e., a kind of *teacher thesis* = 2. Staatsexamensarbeit). The pres-

ent TecSocCon-LS is a result of this work. Prior to this TecSocCon-LS, Sonja had planned and implemented social-constructive learning scenarios without technology. The teacher did not have a role in developing the software tools, but she planned and implemented all teaching materials using the tools. As all other teachers whom we worked with, she was interested in participating in our project "Toolkit" and applied to a call for participation in "Toolkit." Furthermore, she had participated in a specialized training for using the TEE authoring tool and the EF-Editor provided by the research team of the department "Psychology of Learning and Instruction" at Dresden University (PsyLI-TUD).

Mentor. The first two inservice years German teachers work together with experienced teachers supervising and mentoring their classroom activities. Therefore, the English language mentor was present. She had experiences in using social-constructive approaches of teaching and learning, but no experiences in technology enhanced teaching approaches.

Researcher: The PsyLI-TUD-team provided not only the multimedia tools and offered technical training, but also support throughout the duration of the whole project. The PsyLI-TUD-team consisted of a (a) mathematician who had developed the tools and provided technical support, (b) 3 educational psychologists who provided support on how to deal with instructional issues, and (c) several student assistants. One of these educational psychologists was present during the lessons.

Students. The TecSocCon-LS was realized in a seventh grade class at a German high school. The class consisted of 25 students (12 girls and 13 boys) at the age of 12 to 13 in their third year of English. The class had already started working within social-constructive approaches of learning, such as project-oriented learning, in the year before, with a main focus on presentation techniques. All students were in their first year of computer studies. Nevertheless, the experiences and skills concerning the work with new technologies varied among the students: some students were able to use online search engines in order to extract specific information, others had problems in writing and saving a document written in Microsoft Word.

Learning Goals and Teaching-Learning Approach

According to the American Council on Teaching of Foreign Languages, standards for foreign language learning should include *communication* (i.e., practice oral and written communication of the foreign language), *cultures* (i.e., gain knowledge and understanding of foreign cultures), *connections* (i.e., connect with other disciplines and acquire information), *comparisons* (i.e., develop insight into the nature of language and culture), *communities* (i.e., participate in multilingual communities at home and around the world). Many researchers of foreign language teaching claim that theses standards can only be achieved by an active use of the foreign language in authentic scenarios (e.g., Canale & Swain, 1980; Rueschoff & Ritter, 2001).

The present learning scenario aimed at addressing goals related to the standards *communication, cultures, comparison,* and *connections.* More specifically, it focused explicitly on:

- communication goals such as (a) extracting and understanding written and oral information from English texts with a great amount of unknown vocabulary, (b) engaging in conversations on various topics, (c) discussing and exchanging information and opinions, (d) producing and presenting language artifacts to an audience of listeners and readers, (e) furthering and applying grammatical knowledge on how to build and use the passive voice, (f) extending and applying semantic knowledge;
- cultural goals such as (a) gaining knowledge on the city of London, (b) acquiring skills in using London's public transport, (c) understanding aspects of the British way of life in London, and (d) understanding relationships among different cultural aspects of the city of London. These goals were of great relevance for the students because a class trip to London was planned for the following year.

Furthermore, as electronic media displaced print as the dominant media format the goals of the present learning scenario included media literacy goals, namely analyzing and understanding information represented in various formats, and creating texts, combining them with images and representing this combination in an electronic format. By integrating these media analysis and media production goals, we addressed also comparison and connection goals indirectly.

To pursue these language learning and multimedia literacy goals we selected a technology enhanced social-constructive learning scenario (TecSocCon-LS), in the sense of a learners-as-designers and designers-as-learners approach (Jonassen & Reeves, 1996). Such a TecSocCon-LS addresses further learning goals, such as acquiring skills for collaborative, self-regulated learning. From a distributed cognition point of view, teachers *and* students have to accomplish the challenging task of using technical tools mindfully to

- access, evaluate, share, and communicate information from various sources of information,
- integrate, represent, present and discuss states and products of information processing,
- organize, monitor and coordinate individual and group activities.

Material, Resources and Tools

Classroom-hardware infrastructure. The TecSocCon-LS was realized in the computer classroom of the school. The room had two sections: one part was equipped with chairs, desks, blackboard, and an overhead projector and the second part contained a video projector, a wipe board and 16 personal computers (PC). Thus, two students had to work on one PC. All PCs were provided with Internet access and connected via a school intranet accessible by teachers and students from every working station.

Print material. Prior to the learning scenario, students answered a *questionnaire* assessing their prior experiences with technology and with collaborative learning, and their specific interests with regard to the city of London. The

teacher used these answers to prepare scaffolds and instructions for the learning scenario (see instructional TEE-environment). To introduce and attract attention to the city of London, the teacher read the text "Fantasy Trip to London" to the students.

During the learning scenario, the students were provided with a portfolio, called the *London Project Portfolio.* This portfolio consisted of a London map and a tube map, as well as a rough project plan, graphics for evaluating the group work and blank fields for taking notes on the Internet sources and their retrieved information. The portfolio served as a scaffold for initiation and guiding self-reflections on individual and group work. After each unit, students had to respond to the questions and tasks represented in the portfolio. To initiate and guide evaluation at the end of the learning scenario, students were asked to complete evaluation questionnaires concerning essential aspects of social learning and the grading of the final product.

Electronic Resources. The electronic resources of the learning scenario included a set of rich World Wide Web links selected by the teacher, and a set of scaffolding instructional material prepared by the teacher and integrated into the instructional TEE-environment (for an overview see Table 1, p. 292; for a detailed description of these nodes see section *artifacts;* see also Figures 2 and 3). Furthermore, the online dictionary "Leo" (http://www.leo.com) was linked to every node of the instructional TEE-environment. Students were free to use the search engine *Google* to search and access further Web pages they considered to be of interest for their topic.

Software Tools. Students were provided with current Internet browsers, search engines, text-processing and presentation-software, and with the TEE and the EF-editor. TEE supported the teacher in (a) representing, organizing, integrating and storing instructional material and scaffolds in a persistent and easy accessible manner (see instructional TEE-environment; Figures 1, 3, 5. Figure 5 is on page 297), (b) monitoring the progress of the groups in creating their artifacts and responding to exercises, and (c) representing, organizing, integrating and storing the student artifacts into several versions of the tourist guide.

From the students' point of view the *TEE*'s functions included (a) to provide access to the instructional resources and scaffolds prepared by the teacher, (b) to provide tools for representing, organizing and integrating the artifacts they had produced or selected collaboratively in small groups, (c) to distribute or provide access to the artifacts of other student groups which then served as a common ground for meaning making transactions within the whole class, and (d) to provide a progress history or report, which supports reflection on past steps in order to specify further steps.

The *EF-editor* was used to prepare (teacher and students) and answer (students) (a) quiz items for activating prior knowledge and assessing the acquired knowledge through a final *Superquiz*, and (b) exercises for applying grammatical knowledge on the passive voice. It is worth noting here that the *Superquiz* items were prepared within the small group work and integrated by the teacher with the *EF-editor*.

Table 1: Overview on Learning Goals, Print Material, Electronic Resources, and Software Tools

Learning goals	Print material	Electronic resources	Software tools
Media literacy		Instructional *TEE* with	
• access & evaluate information		- set of www-links - scaffold *effective reading*	*TEE,* Internet browser, search engine
• integrate & represent inform.		- scaffold *images* - scaffold *verbs & phrases*	*TEE, EF-editor, Microsoft Word*
• present information		- scaffold *Guided Tour*	*TEE, Microsoft PowerPoint*
Collaboration & Self-regulation		Instructional *TEE* with	
• share & communicate information		- scaffold *Topics* with set of www-links	*TEE, EF-editor*
• organize & coordinate activities and interactions		- scaffold *Your Job*	*TEE*
• plan & monitor activities	- Portfolio - questionnaires	- scaffold *Tower tour*	*TEE, EF-editor*
• present & discuss group artifacts		*TEE-nodes* created by the groups	*TEE*
Foreign language learning			
• oral & written communication		- scaffold *verbs & phrases*	*TEE, EF-editor,* Internet browser, search engine
• cultural knowledge	*Text Fantasy trip to London*	- scaffold *Tower tour*	*TEE,* Internet browser, search engine
• lexical knowledge		Online dictionary	*TEE,* Internet browser
• grammatical knowledge		*TEE*-scaffold *Passive* *EF-exercises*	*TEE* *EF-editor*

Procedure, Activities and Instructional Methods

The TecSocCon-LS lasted three weeks and included five units (90 minutes each, see Table 2, p. 294-295). Within each unit, several teaching and learning activities and several forms of communication and interaction among the participants were combined.

The first unit aimed at activating prior knowledge, stimulating curiosity, introducing the project goals, topics, and tasks. Within this first unit, teacher activities and interactions with the whole class altered with individual student and small group activities. As the topics were derived from the students' questionnaires and they had the opportunity to think about their preferred working partners beforehand, the group building process and the final choice of topics was facilitated.

In the second and third unit, students worked mostly in small groups on the project tasks to produce their artifacts for the Web-based tourist guide with *TEE*. To monitor and discuss the progress of group work with the whole class, the third unit started with a short presentation of the group results, produced so far.

In Unit 4 the small group work continued. Students refined their work, prepared quiz questions, and trained their oral presentations of their group work. During the phases of group work, the role of the teacher was that of a facilitator and a co-learner. The teacher observed and monitored students' work, helped them if necessary in negotiating meaning, engaging in inquiry and research, organizing their material, or creating their own texts and documents.

In Unit 5 each group presented their artifacts produced for the Web-based tourist guide to the teacher and the whole class. These group artifacts were discussed and evaluated by the whole class. To guarantee that all students studied also the contents of nodes of the other groups, students had to study the nodes of their peer-students individually in order to be prepared for answering the *Superquiz.* Finally, the benefits and constraints of the learning scenario were discussed within the whole class. This discussion included the assessment of group work, outcomes, and suggestions for future social-constructive learning scenarios with technology.

Artifacts

Teacher artifacts. The teacher produced and used several artifacts including (a) the portfolio mentioned above, (b) the power point presentation to introduce core information on the city of London, and (c) most importantly, the instructional *TEE*-environment providing not only access to all electronic resources, but also detailed information and instructions concerning the learners' tasks, goals, and scaffolds for individual learner and group activities (Figures 1, 3, 4. Figure 4 is on page 296; see also http://london.mcg-dresden.de/).

The first five nodes (*Guides, Welcome, Sights, Tube, Tube map)* within this initial *TEE*-environment are organized in a linear structure, and had to be accessed in a chronological order. The sixth node (*Your job)* was connected with six supplementary nodes (*Topics, Images, Passive, Reading, Words and Phrases, Guided Tour):*

Table 2: Procedure of the Learning Scenario "A Web-based Tourist Guide for London"

Time	**Artifacts, Tools,** *Resources*	*Goals,* **activities, interactions, Methods—Procedure**
Unit 1 45 min	Text "Fantasy-Trip" PC PPT-presentation Video projector Blackboard, portfolio PCs, video projector Instructional *TEE* *Londonquiz* *Tower Tour for Kids* *Tube map*	*Introduction to topic, project goal, schedule, tool use* - teacher reads text "fantasy trip"—students listen - teacher presents slides of the city of "London," comments them and asks questions—students listen, read, take notes—respond to questions - teacher presents the project idea, the tasks, plan, aims, the grading and the reuse of the project within other classes, hands out the portfolio—students read the tasks and schedule of the project. - teacher presents the tools (the instructional *TEE* prepared by the teacher)—students listen, then work on the *Welcome*-node, the *Sights*-node and the *Tube*-node, and solve the tasks included in these nodes (*Londonquiz; Tube task*)
45 min	PCs video-projector Instructional *TEE* *Londonquiz* *Tower Tour for Kids* *Tube map* *Your job* *Passive* *Guided tour* *Reading, Images, topics* Portfolio	*Preparation, initiation and organization of small group work* - teacher asks how many quiz-items were solved correctly—students report their ideas generated through the work with the *Tower Tour* - students work individually on the *Your Job*- and *Passive*-node (+ exercises) and scan the other nodes - students create groups; topics are selected within the *group*, through scanning the links of *Topics*-node - each group selects a group head, responsible for monitoring group work - teacher explains students' homework (i.e., completing the first two pages of the portfolio)
Unit 2 45 min 45 min	PCs Instructional *TEE* *Londonquiz* *Tower Tour for Kids* *Tube map* *Your job* *Passive* *Guided tour* *Reading, images, topics* Portfolio	*Production of prototype versions, reflection and refinement in small groups* - students work in *small groups*, search for information, use the scaffolding nodes (*passive, guided tour, vocabulary and phrases, reading, images)* if necessary. - within their *groups* students take notes, discuss which information to include into the guide and write the first drafts of the required tour guide - within their *groups* students discuss how to organize the produced documents, in order to integrate them in the Web-based tour guide, - within their *groups* students revise and refine their text documents

		- each *group* prepares a short presentation of advertisement for the guided tours by using the *How to make a guided tour* and *Useful words and phrases*- node - teacher explains students' homework (i.e., completing the pages of the portfolio related to the unit)
Unit 3 45 min	PCs Video projector First draft *TEE* of the tourist guide	*Presentation of prototype versions, reflection in class* - each *group* presents the short advertisement - *whole class* provides feedback and discusses the proposed structure of the students' knowledge map and their produced texts
45 min	PCs First draft *TEE* of the tourist guide Initial *TEE* *Tube map, Your job* *Passive, Guided tour* *Reading, images, topics* Portfolio	*Revision and refinement in small groups* - each *group* revises their texts, produces further texts, creates quiz questions, selects pictures, finds public transport connections, prepares the final presentations by using the scaffolding nodes if necessary - teacher explains students' homework (i.e., completing the pages of the portfolio related to the unit)
Unit 4 45 min 45 min	PCs Video projector Revised *TEE* of the tourist guide Portfolio	*Preparing presentation of final versions in small groups* - each *group* continues refining their presentations - each *group* trains their oral presentation of their created artifacts - students' provide feedback within their groups to the oral presentation of their peers - teacher explains students' homework (i.e., completing the pages of the portfolio related to the unit)
Unit 5 45 min	PCs video-projector Final *TEE* of the tourist guide	*Presentation and discussion of final versions in class* - each *group* presents in class the nodes, they have produced and integrated into the final TEE of the tourist guide - teacher and students evaluate and discuss the presentations, - students study the artifacts of the other groups and take notes, to prepare for the *Superquiz*
45 min	***Superquiz*** Portfolio Questionnaire	*Assessment and evaluation of products and processes* - students solve individually the *Superquiz*, - the rate of correctly answered quiz items is assessed to detect the "best tourists" - students individually evaluate their group work, by completing the relevant pages of the portfolio and answering the researchers' questionnaire - the teacher and the whole class discusses the benefits and constraints of the learning scenario

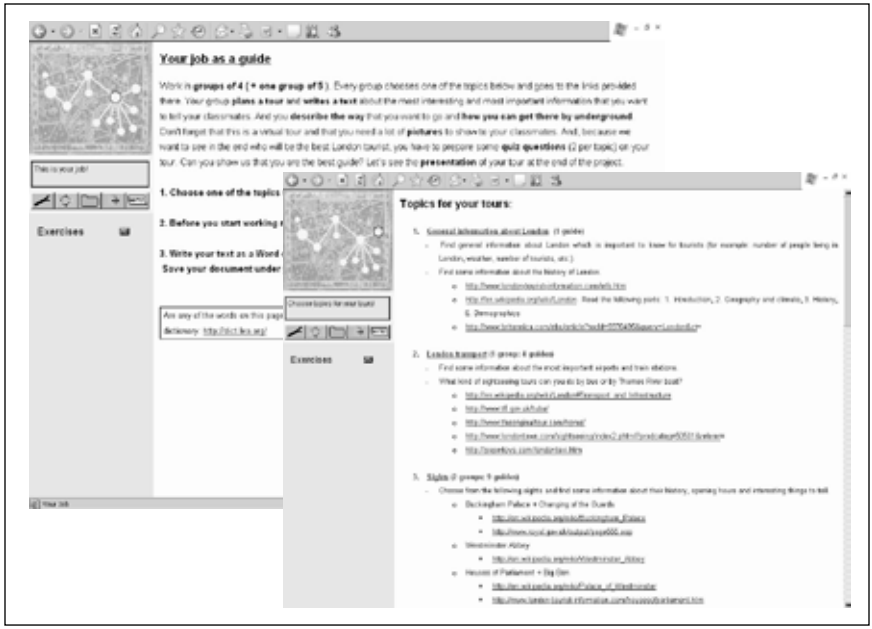

Figure 4: Screenshots of the Your job-Node and the Topics-Node of the instructional TEE-environment.

- The *Guides*-node represents a picture of the class and some information about the class, to increase positive interdependence (i.e., the sense of belonging to the class or group) and individual accountability (Slavin, 1996).
- The *Welcome*-node informs the students about the idea and the contents of the project and offers an EF-exercise to activate their prior knowledge on London. This Ef-exercise consists of a quiz on London, addressing the sights, geographical and historical aspects of the city. Furthermore, the *Welcome*-node includes a picture of the Big Ben, providing access to the sound of its bell. This sound was used as a signal for all participants that the group work periods or the work on the computers was finished and the attention should be focused to the teacher.
- The *Sights*-node provides the students with the *Tower Tour for Kids*, which served as a model for a guided tour and illustrated the results expected at the end of the project.
- The *Tube*-node provides the task describing a trip by tube from the youth hostel the students would stay in to Leicester Square in the center of London. Furthermore, it contains a London tube map and the sound of the "Mind the gap!" announcement.
- The *Your Job* provides the students with their project tasks and the different topics to be chosen by the small groups.
- The *Topics*-node contains a pre-selected choice (made by the teacher) of Internet links where the students could obtain information on the dif-

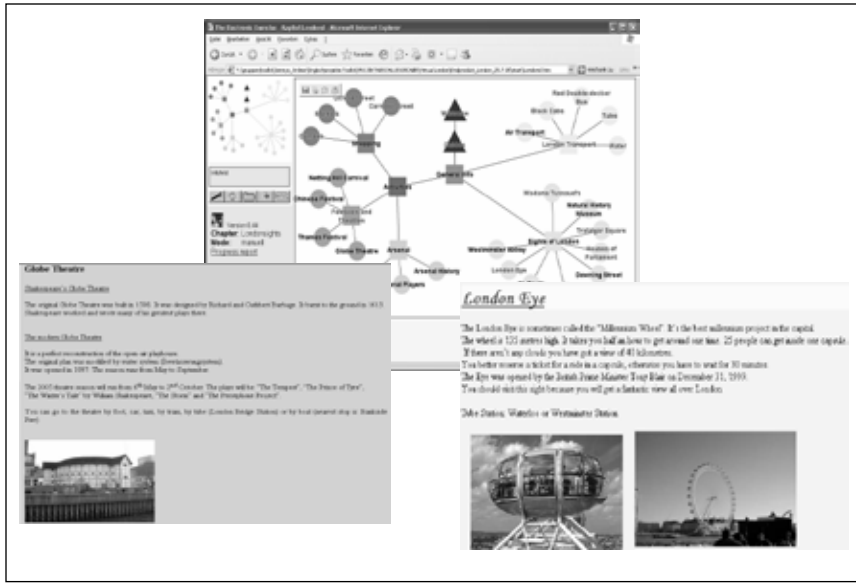

Figure 5: Screenshots of the final structure of the TEE-tourist-guide and of two sample nodes produced by students.

ferent topics and for avoiding the phenomenon of getting lost in hyperspace.

- The *Images*-node offered scaffolds on how to find images on the Internet and store them in an electronic document.
- The *Passive*-node offered instructions on how to build and use the passive voice. Furthermore, as the passive voice had not been sufficiently used in appropriate contexts, an interactive EF-exercise was accessible.
- The *Reading*-node offered scaffolds on how to read texts efficiently in order to extract their relevant information.
- The *Words- and Phrases*-node provided students with useful words, idioms and phrases for the given task.
- The *Guided tour*-node offered scaffolds on how to make a guided tour.
- The online dictionary "Leo" (http://www.dict.leo.org) was linked to every node

Individual learner artifacts. During individual learning phases, the students produced artifacts, such as (a) notes taken during their media analysis tasks, (b) written responses to quiz-items and exercises, and (c) written comments, reflections and experience reports initiated through the tasks with the portfolio.

Small group artifacts. Within the small groups, students created several versions of written artifacts and selected images or interesting Web links for the nodes of their topic. The various versions of the artifacts were continuously organized and integrated with the help of *TEE.* Furthermore, each group created quiz-items on the content of their nodes, which were integrated into the *Superquiz*.

Whole class artifacts. The final artifacts of the small groups were integrated into the final version of the Web-based tourist guide to London with the help of *TEE* (Figure 5).

Figure 5 shows the organization of this Web-based tourist guide to London and several examples of Web pages produced by the students (for more details see, http://london.mcg-dresden.de/). The relations among the nodes represent the thematic groups and were determined by the students. Various colors and shapes of nodes were used for eliciting in the structured overview diagram, which nodes were produced by which group. Using the same colors for the nodes and the background of the students' Web pages facilitated orientation and navigation within the Web based tourist guide. Each page contained a title, self-written text, tube connection, pictures, and quoted sources.

Data Collection and Analyses

The final evaluation aimed at investigating how the teacher and her students assessed the value of integrating technology in a social-constructive learning scenario. To this end, we used a mixed method approach integrating (a) observations and reflections from the teacher, her mentor, and the students, which were collected continuously during the learning scenario, and (b) questionnaires for assessing students' perceptions.

Students' questionnaire. As represented in Table 3, the students' questionnaire consisted of five scales with 38 items addressing *motivation, perceived difficulties in self-regulated learning, perceived gain in media literacy, perceived gain in English communication and cultural knowledge,* and *utility of CSCL-method, materials and tools.* These items had to be answered on a 4-point Likert scale with 1 representing "I absolutely agree" and 4 representing "I absolutely disagree." Furthermore, students were encouraged to provide additional comments, detailing their concerns. The questionnaire was developed on the basis of our previous work in this domain (e.g., Narciss, Proske, & Körndle, 2007).

To analyze the students' questionnaire data we computed for each questionnaire scale the mean score of the ratings for each student. These scale scores were used for descriptive data analyses.

Teacher's observations and reflections. As the teacher used the present learning scenario for her second thesis, she discussed and reflected her observations after each unit with her mentor, and documented the results of these discussions in her *teacher thesis*. The discussions addressed questions concerning teacher perceptions of students' engagement in learning activities and social interactions in the present learning scenario compared to transmission focused teaching approaches. Furthermore, it included reflections on (a) students' gains in language learning knowledge and skills, in media literacy, as well as collaboration and self-regulation skills, and (b) the utility of *TEE* and *EF-editor* for pursuing the above mentioned learning goals.

The data on teacher's observations and reflections were analyzed following principles of directed qualitative content analysis (Hsieh & Shannon, 2005). The focus of interest of this content analysis was on the issues of if and how

Table 3: Structure of the Students' Questionnaire

Scales - subscales	Sample items	Number of items	Cronbach's α
Motivation - intrinsic value - attainment value - utility	- The Internet project was fun for me. - I was very proud of our results at the end. - I enjoyed doing a good job, because my work will be used through the Internet	12 (4) (3) (3)	.77
Perceived difficulties in self-regulated learning	- It was difficult for me to organize my working process on my own without the teacher telling me what to do.	6	.78
Perceived language learning gain	- I learned how to read and use London's tube map. - I learned more about London than I would have done with a teacher-centered instruction	4	.72
Perceived media literacy gain	- I improved my ability to scan Web pages in order to extract specific information.	7	.90
Utility of CSCL-scaffolds	- The continuous documentation of our group work through the daily actualization of the TEE-structure was very helpful.	9	.78

TEE and *EF-editor* facilitated on the one side the practice and acquisition of foreign language communication skills, cultural knowledge, media analysis and media production skills, and on the other side distributed cognition activities, namely sharing and communicating knowledge, organizing and coordinating individual and group activities. To check the reliability of this content analysis we asked the teacher to evaluate the findings of our analysis. Sonja Hannemann expressed a strong agreement with the findings extracted from her *teacher thesis.*

RESULTS

Students' View

The descriptive analysis of the questionnaire data revealed that mostly all students viewed the learning scenario as a positive experience (Table 4, p. 300). Students rated their motivation as rather high, assessed their learning gains in foreign language learning and media literacy as rather high, perceived the scaffolds for the group work as useful, and had experienced not many difficulties in self-regulating their learning process (except time management problems as reported through open comments).

Table 4: Mean Scores and Standard Deviations of Student Ratings to Assessment Items

Variable	Girls		Boys		Whole class	
	Mean	SD	Mean	SD	Mean	SD
Motivation	1.87	.41	1.96	.44	1.91	.42
SRL-difficulties	1.54	.54	1.79	.59	1.66	.57
Language learning -gain	1.73	.47	1.64	.55	1.69	.50
Media-literacy-gain	1.79	.90	1.44	.31	1.62	.69
Utility of CSCL-scaffolds	1.69	.39	1.82	.49	1.76	.43

Note: 1 represents a positive value, 4 a negative value

The open comments revealed that students enjoyed very much the self-regulated group work and were really proud of their final tourist guide. Furthermore, they elicited that the instructional *TEE* and the repeated presentation of student artifacts in *TEE* facilitated students' self-organization of the collaborative learning process, and increased students' interest in the results of the other groups.

Regarding media literacy, the students reported an increase of (a) their word processing and text formatting skills, (b) their skills in converting and embedding images, (c) their skills in searching, analyzing and extracting information in the Internet. Problems were seen in the work with the online dictionary, "Leo" (http://dict.leo.org), because the high amount of possible meanings for each word made it difficult for the students to select the appropriate translation.

Teacher's View

Students' engagement. According to the teacher observations, students' self-reported high motivation and commitment was reflected in their enduring active engagement and effort during the units. The teacher was impressed that this high engagement was even observable during the work with the passive exercises. She considered this engagement and effort higher than in transmission focused lessons. She found it worth noting that this holds true for girls and boys (see also Table 3), which was not the case in transmission focused lessons in which boys' engage far less actively.

Communicating and sharing knowledge. The teacher emphasized the high rate of goal oriented task based communication and knowledge sharing. To her opinion, this rate was higher than in previous social-constructive learning scenarios without technical tools and electronic resources.

Social interactions and coordination among group members. The teacher also reported a high rate of goal oriented learner interactions and activities during the small group work. Compared to previous cooperative learning scenarios, the coordination among group members was more effective and social loafing was hardly observable.

Learning outcomes. To assess the learning outcomes the teacher listed students' learning gains she had perceived with regard to learning goals, namely

communication, cultural knowledge, media literacy, and collaboration skills. This list elicited that *all* students had achieved a rather good level of performance in communication and cultural knowledge. It is worth noting here that the percentage of correct responses of the final *Superquiz* ranged from 71% to 90%, and that the evaluations of the final oral presentations were positive for all groups. Furthermore, the list revealed that *all* students (i.e., boys and girls) had acquired a variety of media literacy skills that they would not have acquired in other learning scenarios (see also *Student's view*). Finally, the teacher found that there were also clear gains in collaboration skill.

Besides the outcomes described in the "Learning outcome" section p. 19 students' artifacts, namely their final presentations of their tour and the Web site, were evaluated qualitatively by the teacher, the mentor, and the peers. To this end, the peers were provided with an evaluation questionnaire consisting of four items addressing (a) the clarity of the presentation, (b) the stimulating use of pictures, (c) the way the students presented their work (free vs. mere reading from documents), and (d) the degree of interest raised by the presentation. There was a high degree of agreement for the qualitative assessment of the teacher, the mentor, and the peers: The presentations of the "Sights-group" and the "Arsenal-group" were considered to be clear and very stimulating because they used interesting pictures illustrating what they described. Furthermore, the students of these groups were able to present their tour in free speech. The presentation of the "Shopping-group" was considered to be clear, yet less stimulating and interesting, because the students of this group were not all able to present their work in free speech.

Utility of TEE and EF-editor. The teacher assessed the utility of the open-ended tools *TEE* and *EF-editor* as rather high. Without *TEE* and the *EF-editor*, she would not have been able to design a Web site with various text documents, images, sounds and exercises. Yet, she found it very helpful (a) to off-load instructional and scaffolding information, by representing, organizing, integrating, and storing instructional material and scaffolds in the instructional *TEE*-environment, (b) to visualize the actual state of work through *TEE* in order to monitor students' progress and detect problems, (c) to initiate and guide social interactions based on the *TEE*-environment, and (d) to have more time for tutoring and scaffolding individual and small group learning activities during the work phases. Furthermore, she emphasized that the knowledge-map-like structure of a *TEE*-environment facilitated not only the organization of instructional artifacts, but also the organization and management of the schedule of the learning scenario, because she was forced to think about which core events and activities should take place when and how, and which artifacts, tools, and scaffolds should be provided. Hence, compared to her prior experiences with social-constructive learning scenarios, she invested more time in preparing the instructional and scaffolding material. Even though the preparation of the instructional *TEE*-environment was rather time-consuming, she considered it worth the effort.

Constraints related to technology. Two main constraints of using technology for social-constructive learning scenarios were emphasized in the teacher the-

sis: First, she experienced a technical load, because she was no expert in using technology for teaching. Second, she experienced an additional organizational load which consisted of (a) organizing the access to the technical hardware tools several weeks in advance because the school was far from providing several PCs or laptops per class (actually, German schools have on average 1 PC per 18 students, that is one or two classrooms equipped with PCs), (b) arranging the PC-equipped room in such a way that it is also usable for whole class activities such as presenting and discussing group results, (c) organizing video projectors or other presentation tools enabling the teacher and the learners to present artifacts to the whole class, (d) organizing students' individual access to hardware tools and software tools, (e) preparing student logins, determine how they should function, and how they will be administered, in order to provide students with the possibility of storing their produced artifacts, and (f) checking if all technical tools run without problems if they are used by several students or groups at the same time.

DISCUSSION

Using the DC-framework for describing and analyzing in detail the present technology enhanced social-constructive learning scenario (TecSocCon-LS) reveals that technical tools such as *TEE* and the *EF-editor* can contribute a great deal to prepare and implement a social-constructive learning scenario. More specifically, *TEE* and the *EF-editor* supported students' (a) active engagement in individual and/or collaborative language learning activities (e.g., searching, reading, analyzing information; exchanging understandings, negotiating choices, opinions, meanings), (b) organization and self-regulation of their learning processes (e.g., specifying and negotiating goals, tasks, schedules and responsibilities within their groups; monitoring progress, evaluating and reflecting processes and products), (c) practice of media literacy skills, such as analyzing, producing and representing English artifacts in an electronic format (e.g., reading and writing texts, finding illustrative images, organizing and integrating the produced artifacts; discussing ways of organizing and integrating artifacts), and (d) practice of individual and/or collaborative media presentation activities (e.g., presenting and explaining contents and structure of artifacts).

From the teacher's point of view, *TEE* and the *EF-editor* reduced not only the operational load related to designing and providing electronic access to authentic learning artifacts, but it also offered new ways of off-loading teacher tasks such as (a) providing clear instructions, tasks and scaffolds, (b) providing guidance for social interactions and fostering individual accountability and positive interdependence, (c) assessing and monitoring the learning processes and outcomes, (d) helping students to reflect individually and collectively their activities, interactions and outcomes and (e) providing various types of practice for acquiring not only language learning skills and knowledge but also media literacy.

These new ways of off-loading teacher tasks contributed to a shared pool of easy accessible resources, instructional and scaffolding artifacts, etc., for all participants of the learning scenario. From a DC and from a social-constructive

point of view, such a shared pool provides a common basis for communicating and sharing knowledge and information among all participants of a TecSocCon-LS, as well as for monitoring and coordinating individual and group activities. It can thus help to overcome the *common ground, unshared knowledge*, *interactive structure*, *epistemic* and *motivational barriers* mentioned in the introduction (Bromme et al. 2005).

The analyses of students' questionnaires and the teacher observations and reflections provide evidence that within the present TecSocCon-LS these barriers were coped with rather successfully. Yet, besides the easy access to the above mentioned pool of resources and artifacts, the present strategies of fostering accountability and positive interdependence, namely the goal to design a tourist guide, prepare the class trip to London, and the picture of the class, the continuous visualization of the state of task completion might have helped to overcome in particular the *interactive structure* and *motivation barriers*.

Limitations

From an outcome-oriented point of view, these findings might be qualified because they detail how *TEE* and the *EF-editor* served important DC and social-constructive functions, but provide only qualitative data that students achieved (a) a higher level of performance and (b) a higher efficiency in coordinating their group activities than in other teaching approaches. Unfortunately, these previous teaching approaches were not systematically evaluated with regard to the effectiveness of social interactions and cooperation. Thus, a quantitative analysis of the differences in achievement and social skills was impossible.

Furthermore, the present results might be limited, because it is very difficult if not impossible to disentangle the effects of (a) a very interesting project theme (i.e., preparing a trip to London), (b) mere practice of cooperation, and (c) the technical tools.

Implications for Future Research and Practice

The issue of assessing in detail the outcomes of learning scenarios with technology is certainly an issue that deserves further investigation. Yet, to address this issue, future studies should use research approaches that allow better control of factors such as practice effects. This was not at the scope of the present work, which aimed at eliciting the value of the DC-framework for investigating the benefits and constraints of using *TEE* and the *EF-editor* in a "real" social-constructive learning scenario. In summary the present work reveals that the DC-framework provided heuristics (a) to analyze in detail the complex structure of a social-constructive task environment, (b) to identify which resources, tools, activities and interactions are useful to pursue the various learning goals, and (c) to develop strategies of pooling resources and tools in order to provide a common ground for communication and knowledge sharing, as well as coordinating activities and interactions.

Furthermore, in applying the DC-heuristics several important differences between small sociotechnical systems and TecSocCon-LSs became apparent. These differences include (a) a small set of specific goals and task requirements versus

a large variety of learning goals and task requirements, (b) few actors with a homogeneous level of expertise versus many actors with a heterogeneous level of expertise in accessing, evaluating and communicating information with technical tools, (c) a restricted set of materials, resources and tools specifically tailored to accomplish the specific task requirements versus a large variety of materials, resources and tools from which the teacher has to select the most appropriate for the given set of learning goals, (d) a restricted set versus a large variety of activities and interactions, and (e) a restricted set versus a large variety of artifacts used and produced by the actors. Future studies should investigate these differences in more detail.

These differences attract, on the one hand, attention to the theoretical issue of how the DC-framework should be enhanced to better understand such complex social-constructive systems. On the other hand, they raise the important issue of how teachers have to be educated in order to be able to cope with the challenges related to the complexity of TecSocCon-LSs. To design learning scenarios with technology in which students are provided with authentic situations and material to engage actively in communicating and constructing knowledge, teachers need more than technical or operational skills for handling the technical tools. They also need knowledge and skills on how to (a) specify smart goals and tasks for individual or collaborative learning activities with authentic material and resources, (b) develop scaffolds for individual and collaborative learning activities, (c) select appropriate resources and tools, (d) support the coordination of effective social interactions, namely knowledge sharing and communication, (e) monitor and assess the learning process and outcomes, (f) help students to reflect and monitor their activities, interactions, and outcomes individually and collectively, and (g) provide various occasions of emphasizing, practicing and repeating critical knowledge and skills. The efficient application of this knowledge and these skills is rather challenging and needs deliberate practice. Thus, teacher education programs should include not only the mere acquisition of operational skills, but also examples of best practices in using technical tools in the sense of cognitive tools for teaching and learning. Yet, up to now, teacher education programs do not systematically prepare preservice *and* inservice teachers to teach with technology (Angeli, 2005).

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