Support to teachers within systems for computer-supported collaborative learning

Marina Žunić
University of Rijeka, Department of informatics
R. Matejcic 2
51000 Rijeka, Croatia
+38551584703
marina.bajcic@inf.uniri.hr

Martina Holenko Dlab
University of Rijeka, Department of informatics
R. Matejcic 2
51000 Rijeka, Croatia
+38551584708
mholenko@inf.uniri.hr

ABSTRACT

In order to support interaction among students during learning activities, systems for computer-supported collaborative learning (CSCL systems) are increasingly used. This paper gives an overview of existing CSCL systems with emphasis on the support provided to the teachers. Two main types of support are identified. Those are support for planning of collaborative learning and support for management of collaborative learning. Existing CSCL systems that provide support for management of collaborative learning are further classified according to the level of support. Furthermore, possible improvements of system ELARS that support the planning and management of collaborative learning are proposed in order to provide additional support to the teachers.

CCS Concepts

• Applied computing→ E-learning • Applied computing→ Interactive learning environment • Applied computing→ Collaborative learning

Keywords

Computer-supported collaborative learning, collaborative learning, teachers' role, support to teachers, ELARS.

1. INTRODUCTION

The use of collaborative learning [7] was popularized in the 1980s with the publication of the first meta-analysis of the impact of collaborative, competitive and individualized lessons designed to achieve better results and achievements in the learning process [17]. Collaborative learning has a strong positive influence on achievement, socialization, motivation and personal development of students [16] and can be used to acquire skills such as communication, tolerance among participants, reciprocity, empathy, division of tasks, mutual respect and assistance, and adaptation [18]. During collaborative learning, students are encouraged to learn actively by applying different teaching methods. The presence of successful collaboration during learning activities depends on whether the following conditions are met [27]: existence of a common goal, positive interdependence among peers, coordination and communication among peers, individual accountability, awareness of other peers' work and joint rewards.

In Computer-Supported Collaborative Learning (CSCL), technology is introduced to enhance the process of collaborative learning. As technology becomes more and more advanced, CSCL systems are more often used to support the interaction among peers in order to facilitate the achievement of learning outcomes [21]. In an attempt to establish a better interaction among peers, Intelligent Tutoring Systems (ITS) are often combined with CSCL systems into intelligent CSCL system. This systems try to improve results of students' collaborative learning activities by using different intelligent techniques [5]. Besides supporting collaborative students' activities, it is important to emphasize the need to support teachers in planning and managing of CSCL activities.

By introducing collaborative learning strategies, the role of the teacher becomes more demanding. Due to the quantity and variety of tasks the teacher has to take care of, the teacher is often referred as the orchestrator of learning process [24]. In addition to preparing learning materials, ensuring online socialization and creating a pleasant work atmosphere, teacher's role is to guide and encourage students in the learning process [31]. With the support within CSCL systems, teachers can be more efficient in carrying out these tasks. For example, teacher can get insights into the activity levels of all students/groups [15], level of student collaboration [1] and learning process [30]. Another example of task often done by teachers is process of group formation, which affects the effectiveness of collaborative learning and social behavior of participants within the groups. Teachers can use the advantages of technology in order to automatically group students according to desired criteria [19] that could include students' achievements, learning styles, mutual relationships, students' interests and similar. According to [23], several types of support to students can be defined: *pedagogical support* (focused on student learning), *social support* (focused on student relationships and maintaining their motivation), *interaction support* (focused on maintaining student activities and encouraging mutual communication), *management support* (focused on task design and monitoring students' work while solving them), and *technical support* (focused on tool selection and detection of operational and technical difficulties).

Purpose of the research presented in this paper was to identify the types of support to teachers within CSCL systems and possible improvements with the aim of reducing the teachers' workload. The two main types of support have been identified (Figure 1): support for planning and management of collaborative learning. The paper

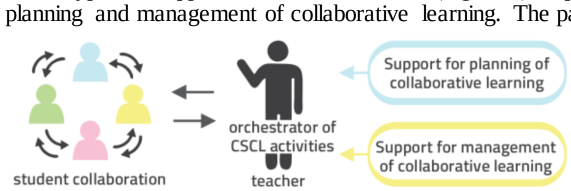

Figure 1. Support to teachers in the CSCL systems

also gives an overview of the existing systems that provide support for management of collaborative learning. Furthermore, guidelines for further development of the ELARS system that support the planning and management of collaborative learning are proposed in order to provide additional support to the teachers.

2. SUPPORT TO TEACHERS IN THE CSCL SYSTEMS

2.1 Support for planning of collaborative learning

The process of planning computer-supported collaborative learning includes defining instructions for tasks, management plan, and online learning environment [22]. First, teachers should plan workflow of activities and define task type and structure, learning methods, available time and way of interaction among peers for each planed activity. Besides interaction among peers, it is also important that the teacher plan his/her interaction with students for providing support, feedback and guidance as well as to define what students' actions will be monitored in order to accomplish these managing tasks [7].

In case of collaborative learning activities, teachers should specify the criterion for group formation that includes number of group members. Students can form groups by themselves or the teacher can create groups according to students' characteristics, manually or with the support of the CSCL system. In addition to creating groups, it is necessary to define roles within a group in case the chosen interaction mode assumes a division of work [14].

Figure 2 shows an example of activities workflow in an e-course. The e-course starts with an introduction and ends with a final test. Between these two elements students acquire knowledge through lectures or learning materials. Afterwards, they take online test and collaborate on a given task in CSCL activity. It is planned that students participate in one CSCL activity for each topic so there is a sequence of activities that is repeated during an e-course. Design of CSCL activity can be planned in more detail. In the given example, students get instructions for the activity, are divided into groups, perform the task and then present their group results to others.

Another task for teachers during the planning of collaborative learning that is mentioned before is choosing the online learning environment. It is important that chosen learning environment meets the needs of designed CSCL activities. In addition to chosen CSCL system that will enable delivery of learning content, communication among teacher and students, online testing and similar, various digital tools available on the Web can be used (Web 2.0) [25]. These tools provides students to collaboratively create and share digital contents (e.g. text files, wiki documents, drawings, diagrams, etc.) [6]. Another example of Web 2.0 tool that can be included in the CSCL environment are Digital badges and their

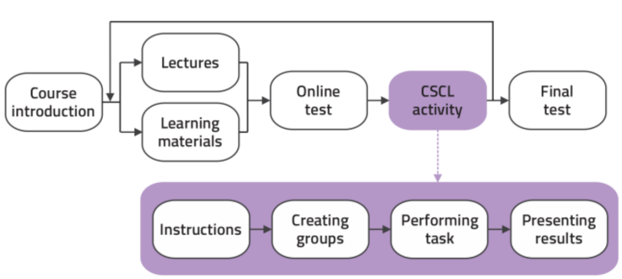

Figure 2. Course model with collaborative learning activities

purpose is to motivate students to be active and to encourage collaboration among peers. Collected badges represent student's accomplishments and since they are assigned as a reward, usage of digital badges brings an element of a game (gamification) to the learning process [9].

2.2 Support for management of collaborative learning

During management of collaborative learning, teacher's role is important from the beginning of the learning process. Teachers should encourage students to be active and to interact with their peers, ensure that they get acquainted with the chosen CSCL system and tools that will be used in the learning process, as well as to help them with technical problems if they occur [28]. In addition, teacher should guide students through the planned learning activities and give them feedback about their work. Management takes place in several phases shown on Figure 3 [26] that compare the current state of interaction among students with the desired state of interaction:

1. *Collecting interaction data* - At this stage, interaction is monitored and recorded.

2. *Creating an interaction model* - After gathering information, the indicators that represent the current state of interaction are selected. (e.g. indicator of an agreement can be obtained by comparing one or more students' problem solutions).

3. *Comparison of the current state of interaction with the desired one* - The desired model is defined as a set of indicators that describe the productive and unproductive state of interaction. These indicators usually correspond to collaborative interaction features like student participation (students should interact frequently and equally).

4. *Advising and interaction guidance* - If a difference between the current and desired state of interaction appears in the previous stage, changes that would increase their interaction status can be suggested.

5. *Evaluation of interaction monitoring* - after suggesting improvement of interaction, once again the whole cycle is checked, and it is verified whether improvements have been made to the previously unproductive state.

According to [26], tools that support teachers in managing tasks can be classified to mirroring tools, metacognitive tools and guiding systems (Figure 3).

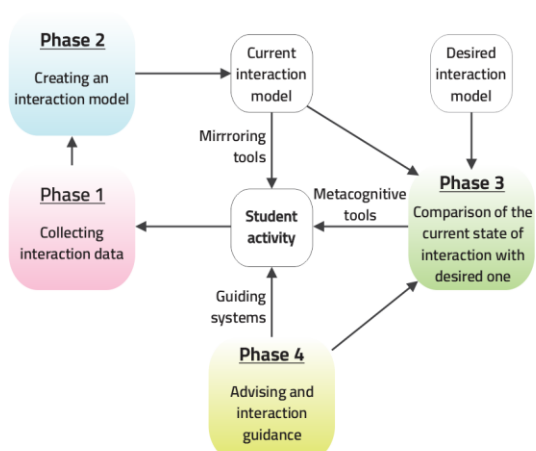

Figure 3. Management of collaboration process

The first type of tools are *mirroring tools* that are used to raise students' awareness about their activity during collaborative learning. Such tools collect student interaction data via log files in the first and second phase. The data is then displayed to students in order to enable them to see their achievements during the learning process. Insight into the students' activity is also available to teachers who can then try to increase the activity level of less active students. *Metacognitive tools* contain information about the current state of interaction and compares it to desired state based on defined indicators. This provides support to the teacher in the process of evaluating students' work and providing feedback, which contributes to improvement of the learning process. Students can also have insight into their current state and make this comparison independently. *Guiding systems* advance the functionalities of *mirroring* and *metacognitive* tools by suggesting actions to students in order to provide the support to teacher in the process of conducting the collaborative learning by facilitating the achievement of the desired state. This include proving awareness support, presenting recommendations, advice, warnings, and similar.

Considering the phases that they include and the tools they use, systems can be classified to three subtypes: systems that show actions, systems that monitor the state of interaction, and systems that provide advice. Short descriptions of existing systems classified to above-mentioned subtypes can be found in Table 1.

Systems that show actions cover only first and second phase. These systems display students' actions to teachers and other students in order to provide awareness (students are aware of their actions and can compare it to actions of their peers). These systems do not take any other action with the collected data. *Systems that monitor the state of interaction* collect interaction data and define a group of identifiers which are presented to the students who can independently compare their current state of interaction with the desired one. Some systems do not show the results to the students but only to teachers/researchers who will use them to understand and explain the students' interaction state. This type of systems covers the first three phases shown in Figure 3. The most advanced systems, which comprise all the mentioned phases from Figure 3., are *systems that provide advice*. These systems analyze the current state of interaction by comparing it with the desired interaction model and then provide advice to students. By providing advice to students in order to increase the efficiency of the learning process, such systems significantly facilitate the teacher's tasks during the conduction of CSCL activities.

One of the systems among examples in Table 1 is educational recommender system ELARS [12] which supports teachers in planning and managing collaborative learning activities. ELARS enable teachers to plan the activities workflow and organize individual and collaborative activities with the help of Web 2.0 tools. The system recommends optional learning activities, possible collaborators (student peers), Web 2.0 tools and offers advice to students regarding their participation in CSCL activities [15]. It also enables an automatic creation of groups based on a defined criterion [19]. Guidelines for further development of the ELARS system with the aim to provide additional support to teachers are described in the reminder of the paper.

3. GUIDELINES FOR FUTURE WORK

Further development of the ELARS systems will include both types of support to teachers: support for planning and support for managing of collaborative learning.

Regarding the planning of collaborative learning, support will be provided in the process of designing the activities workflow. Designing CSCL can be a demanding task, especially for inexperienced teachers. Therefore, teachers will be provided with a set of templates with CSCL activities created by the experts (e learning designers) and other teachers. The templates will serve as examples of good practice of various collaborative learning strategies like problem-based learning, project-based learning, and inquiry-based learning.

In addition to designing CSCL activities, teachers need to find an online learning platform and tools that would meet the needs of the designed activities. For that reason, the support to the process of creating online learning environment will be provided. Since there are many available digital tools that proved to be useful for conducting collaborative activities, a repository of tools will be created within the ELARS system. Using the repository, teachers will have the opportunity to browse tools that will be grouped according to their purpose (e.g. tools for collaborative writing, media exchange, creative learning, social networking and tools that replace desktop application) as well as the ratings the tools were given by other teachers. In addition to information about particular tools and examples about their use, teacher will be provided with recommendations about the appropriate tools for the CSCL activities that he/she planned.

Besides planning various collaborative activities that will be performed with digital tools (Web 2.0 tools), achievement of learning outcomes can be assessed with tools available in the CSCL system. Further development of ELARS system will include a tool for solving tasks that require the practical application of theoretical knowledge from the STEM area. In such tasks, students should conduct complex mathematical procedures and calculations that include a sequence of defined steps. Instead of checking only the accuracy of the final solution, the system will provide feedback to students regarding the correctness of all steps in the procedure. The system will also support teachers in monitoring students' actions and guiding them to the final solution of the given problem.

Teachers should not focus only on cognitive student activities, but also should support students' to be active and to interact with peers. Therefore, addition support to teachers in the process of managing collaborative learning is planned. This include creation of structured and graphical representations of students' (inter)activity. There will be possibility that the teacher filters relevant data in order to get information needed to guide students towards the desired state of interaction. Teacher's workload will be additionally reduced by sending automatic reminders to students (e.g. reminders of deadlines for choosing the group members, submitting task solutions, etc.) and alerts to teacher in cases difference of current state from the desired state is detected.

4. CONCLUSION

Implementation of collaborative learning implies a number of tasks that need to be carried out by teachers. Therefore, support provided within the systems for computer-supported collaborative learning is necessary in order to reduce the teachers' workload.

In research presented in this paper, two types of support for teachers have been identified: support for planning and support for managing collaborative learning. In addition, guidelines for future development of ELARS systems in order to facilitate the teachers in these tasks have been proposed. These include supporting teacher in planning the collaborative learning by offering templates of frequently used activities workflows that correspond to the desired pedagogical approach and recommending appropriate digital tools. It also includes supporting teacher in managing and conducting planed collaborative learning activities by improving the teacher's ability to filter relevant data regarding student performance and providing teachers with advice and warnings in order to enable them to better guide students towards the desired state of interaction.

Table 1. Overview of CSCL systems that support managing

1. Systems that show actions			
System name	**Monitored actions**	**Display mode**	**Visibility of actions**
ART /SAILE [10]	Student activity through online chat	Graphical representation through circles (larger circles and stronger colors for active students)	Students see each other's actions
CSCL-MAS [2]	Student interaction; level of participation; group progress	Graphs	Students only see their own actions
Connection Log [4]	Time spent on defining a problem; search for relevant information; coming to a solution	Graphs	Students see their actions and actions of group members
2. Systems that monitor the state of interaction			
System name	**Monitored actions**	**Models**	**Purpose of monitoring**
EPSILON [26]	Level of activity during interaction; providing relevant information	Effective and inefficient knowledge sharing	Points to the part where students had difficulties
VMT [1]	Level of system efficiency and student collaboration	Satisfaction and dissatisfaction with the system	System improvement
Learning Cell System [30]	Learning process	Creating learning cell, browsing, collaborative editing of a learning cell, remark, reflection	System improvement
Betty's Brain [8]	Student activity	Collecting information, creating a mental map and working on a mental map	System improvement
FACT [29]	Student activity through audio files	Active communication or no communication; level of co-operation (independent activity, group activity guided by one student and group activity with equal contribution)	System improvement
3. Systems that provide advice			
System name	**Monitored actions**	**Models**	**Advice**
ELARS [13]	Individual and group interaction with Web 2.0 tools; providing preferences; tests results	Learning styles preferences; Web 2.0 tools preferences; knowledge level and activity level	Recommends e-activities, collaborators and Web 2.0 tools for student or a group, provides advice to increase activity level
OXEnTCHE [20]	Student interaction	Productive and unproductive interaction	Provides advice to students for mutual conversation to remain in learning domain; encourages not active students to participate
Collab-ChiQat Tutor [11]	Individual and group interaction while using the system and working on audio tracks	Compare the number of words or pronunciations related to learning domain	The teacher with the help of the system provides advice to students based on collected data
dotLRN [3]	Student interaction through forum	Appropriate and inappropriate behavior	Warns students about the potential problems within their interaction by showing them individual results in the form of tips

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Authors' background

Your Name	Title*	Research Field	Personal website
Marina Žunić	PhD candidate	Technology enhanced learning (e-learning)	https://portal.uniri.hr/portfelj/2528
Martina Holenko Dlab, PhD	Postdoctoral Reasercher	Technology enhanced learning (e-learning)	http://portal.uniri.hr/Portfelj/496