FAST - Flexible Assignment System[1]

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Abstract: Nowadays the usage of collaborative learning in e-Learning environments is becoming very popular. Even so, there is a lack of web-based assignment systems supporting collaborative learning. In this work, I report on a novel assignment system for organizing and realizing web-based exercises. This new flexible assignment system makes it possible to design and perform different exercises in various collaborative learning-settings. For example, exercises can be arranged as tutorials as well as peer assessments. For an effective implementation of collaborative learning environments, the learning process must be structured. That can be done through so-called collaboration scripts and statechart diagrams.

1. INTRODUCTION

E-Learning is a useful method to study in a flexible way. Two main steps are necessary for studying independently from time and location. The first step is to organize the virtual knowledge transfer. This can be done through web-based trainings or lecture recordings. The second step is to organize and realize web-based exercises (Ottmann & Trahasch 2005). Exercises are important for two reasons: On the one hand, by solving exercises, the students can put the knowledge from the lectures into practice and on the other hand, the lecturer can use exercises to verify the progress of the students.

In conjunction with exercises, assessments are fundamental. Many different forms of assessments are possible. One can assess an individual or a group. A lecturer, a tutor or a student can perform an assessment. An assessment can be summative or formative. With summative assessments, the standard of knowledge can be measured. This form of assessment can be used to grade learners and to certify competence. Usually summative assessments play an important role in tutorials. To perform exercises in tutorials over the Internet systems like WebAssign or ECLAUS can be used. Formative assessments facilitate the learning process in a stronger way than summative ones. Generally, formative assessments are used in peer assessments. Peer assessment is defined as an arrangement in which students review artifacts of other students. Systems like OASYS or Peer Grader can be used to create network-based peer assessments.

The problem is, even though all systems for these assessment methods have similar functionality, the usage of different applications is needed to fulfill all the requirements. Another problem is that many existing systems do not support collaborative learning. Therefore, I present in this work an application I developed during my diploma thesis. Using this application, it is possible to design and realize different exercises for different collaborative learning-settings in a flexible way.

This paper is organized as follows. In the next section, CSCL (Computer Supported Collaborative/Cooperative Learning), its advantages and disadvantages are explained and I introduce a formal description of collaborative exercises. In Section 3 I describe some collaborative exercises that can be realized with my application and show the requirements of a flexible assignment system. Section 4 gives a short overview of current existing systems and describes their limitations. Section 5 contains the description of the application and its key features based on the formal specification introduced before. In conclusion, Section 6 discusses several possible extensions for future work.

2. CSCL

The main question in the research area of CSCL is: How can computers, software systems and network technologies support collaborative learning (O'Malley 1995)? The combination of technical systems and pedagogic-didactical methods is essential for an effective implementation of a collaborative learning

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environment.

Dillenbourg (1999) defines collaborative learning as a situation in which at least two people learn together. Collaborative learning is a method which enables learners to acquire deeper knowledge in a subject, improve creative thinking skills and social processes. The aspects of collaboration which enhance learning are construction of a common knowledge within the group, cognitive elaboration and multiple perspectives.

Advantages

Collaborative learning can lead to a higher learning motivation and to an extended knowledge base. Another benefit is that multiple perspectives to a problem can occur, which facilitate the knowledge transfer. In addition, collaborative learning can lead to an examination through various viewpoints, which enables a deeper understanding as well as an elaboration of one's own viewpoint within the discourse with the other learners, which also supports understanding (Hinze 2004).

Disadvantages

The following problems can occur in the context of CSCL. Firstly, the same negative effects which can be observed in conventional teamwork such as coordination problems or the presence of freeloaders can also occur in CSCL. Additionally, other problems can result from the virtual context and the particularities of the computer-mediated communication. The absence of social presence, the problematic coordination of the group activities, the information overload and a missing connection between the messages can have disadvantageous effects on the collaboration of the learners (Hesse & Hron 2002). Another point is that grounding (i.e. the process to maintain some degree of mutual understanding) can be difficult because of the reduction of context information and the lack of non-verbal signals (Clark & Brennan 1991).

Collaboration Scripts

In order to use collaborative learning in a successful way and to reduce all these disadvantages, the learning process must be structured. Collaboration scripts are a possibility for such a structuring. These scripts define a set of phases and rules according to which the collaboration proceeds. Collaboration is structured by defining tasks, deadlines, roles, how to form groups, etc.

Based on the definition of Dillenbourg (2002) I have designed a collaboration script describing the different phases of collaborative exercises. Each phase is specified by the following five attributes.

1. **Task:** This attribute describes what participants have to do in this phase. Each task can be described in more detail by defining input, activity, and output.
2. **Group:** This attribute determines the group formation.
3. **Distribution:** This attribute defines how the task is distributed over the members of the group or over several groups.
4. **Mode:** This attribute decides on the mode of interaction.
5. **Timing:** This attribute identifies the duration of the phase.

It is not necessary to declare the third item explicitly, since it can be expressed through the syntax of the task and the group description.

3. COLLABORATIVE EXERCISES

Some different types of exercises are introduced in this section, which can be realized in a collaborative way. As an example, one of these exercises is formally specified using collaboration scripts and statechart diagrams. The other exercises can be specified in the same way. The requirements for a flexible assignment system are also shown.

Tutorial exercises

At universities, exercises are normally performed as tutorials. Lecturers periodically give students an exercise sheet, which sometimes must be solved individually, but usually in small groups. A tutor corrects and assesses the solutions summativly. After the correction phase, the tutor presents the master solution during a tutorial and discusses it with the students. Students can ask questions about course topics they did not understand.

Assessment and annotation of a research paper

The aim of this exercise type is the acquirement of metacognitive skills (i.e. the analytical abilities of students should be trained). The lecturer offers some topics with research papers and a set of assessment criteria. Students

can choose a topic and assess a research paper based on these criteria. After the assessment phase the lecturer discusses the papers and the assessments with the students.

Learning diary

The creation of learning diaries is another collaborative learning arrangement. A learning diary is a continuous protocol which the learner must write to reflect on his learning process. By writing learning diaries, the learner reflects on his learning experiences and outcomes from classroom sessions. Through the regular postprocessing of the learning materials during the creation of a learning diary, the processing of the learning material will be deepened, several topics will be cognitively linked together and interconnections to topics from other courses and to the learner's previous knowledge will be established. Furthermore, the learner should critically reflect on his own learning activities and should take the responsibility for his own learning process. The entries of the learning diaries can be assessed by the lecturer or other learners, which will improve the quality of the learning process and help to diagnose missing or misunderstood knowledge.

Peer Assessment

Peer assessment focuses more on learning and merges the learning process with the assessment process. Topping (1998) defines Peer assessment as follows:

> *"Peer assessment is defined as an arrangement in which individuals consider the amount, level, value, worth, quality, or success of the products or outcomes of learning of peers of similar status."*

Peer assessment can yield gains in cognitive and social skills. For students the main benefit of peer assessment is that they have to take up different roles such that multiple perspectives arise. While the students solve an exercise they are in the role of a learner and while they assess the solutions of other students they take the role of an assessor. By giving feedback to other learners, they can see how others solve problems and can think more deeply about the problem. By doing peer assessments, students must shoulder the responsibility of their own learning, which can lead to a greater motivation and deepen their understanding. Other benefits of peer assessments for students are that skills of critical reflection and analysis can be trained. Students can learn to give and accept criticism and they can detect and improve missing knowledge.

Table 1 shows a collaboration script describing the different phases of peer assessment on the conceptional level. This script is based on the definition of Dillenbourg and consists at least of six phases. Each phase is defined by specifying the *task* by the triple *input*, *activity* and *output*, the *group* by the tupel *mode* and *handled by*, the *mode of interaction*, the *timing* and the *role*.

Another alternative for modelling the learning process is a statechart-diagram. Figure 1 shows the statechart-diagram of peer assessment. The states of this diagram represent the phases of peer assessment. A transition from one phase to the next occurs when a role fulfills the necessary activity of the current phase. Using this representation it is easier to see the alternatives and loops of the peer assessment process.

Peer assessment with discussion of assessment criteria

A variant of peer assessment is peer assessment with discussion of assessment criteria. In this form of peer assessment, the lecturer discusses the set of assessment criteria for the assessment phase with the students before he defines them. The discussion provides the benefit that the students get a precise idea of what is needed for a very good work, so the students' attention is directed to the important factors.

Requirements for a flexible assignment system

A flexible assignment system must fulfill the following requirements:

- Flexibility
- Grouping
- Teamwork
- Possibility for structured communication
- Representation of collaboration scripts
- Upload, download and management of documents
- System roles
- Several correlation strategies
- Functionality for assessments
- Overview of assessments and statistics
- Authentication and privacy

4. RELATED WORK

Brunsmann et al. (1999) describe the web-based system WebAssign that supports the administration of tutorials. WebAssign was developed at the German Open University Hagen (Fernuniversität Hagen). It provides different

Table 1: Collaboration script for a peer assessment

Title:	Peer Assessment							
Objectives:	Deepening knowledge; Summarizing learning materials; Understanding of criteria of a good work							
Workflow								
Phase	Task			Group		Mode of Interaction	Timing	Role
	Input	Activity	Output	Mode	Handled by			
1	-	Conceptual formulation; definition of a set of assessment criteria	Conceptual formulation (description + opt. document, set of criteria)	-	-	-	-	Lecturer
2	List of students	Build learning groups	List of learning groups	-	-	-	Fixed time	Lecturer
3	Conceptual formulation, group information	Create artifact	Artifact	Learning group	All	Workspace Forum	Fixed time	Author ∈ {member of learning group}
4	List of reviewers, list of artifacts	Choose mapping strategy and assign	List of assignments	-	-	-	Fixed time	Lecturer
5	Artifact	Assess artifact on the basis of a set of criteria	Assessments	Individual	All or some	-	Fixed time	Reviewer ∈ {student, tutor, lecturer}
6	Assessments and artifacts	Evaluate assessments	-	Individual	All	-	Fixed time	Beholder ∈ {student, tutor, lecturer}
Alternative 1								
7	Assessments	Assess assessments (Backward-Feedback) How helpful were the assessments for the revision?	Assessments	Individual	All or some	-	Fixed time	Reviewer ∈ {student}
	go to phase 6							
Alternative 2								
7	Assessments, artifact	Revise artifact	Artifact	Learning group	All or some	Workspace Forum	Fixed time	Author ∈ {member of learning group}
	go to phase 5							

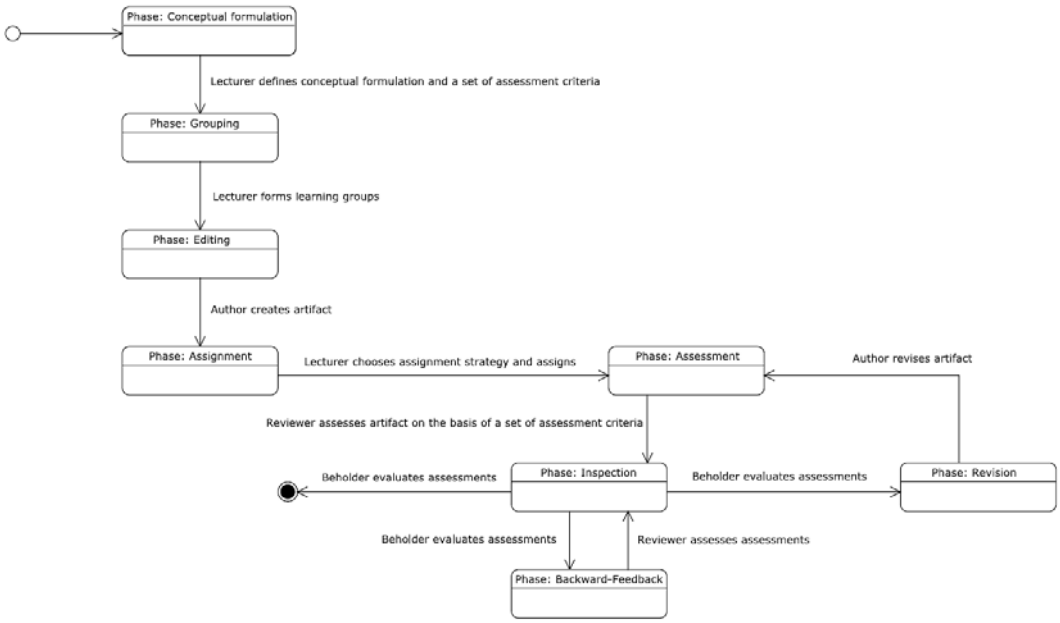

Figure 1: Statechart-diagram for a peer assessment

types of assignments and correction modes such as multiple-choice tasks, which are automatically assessed, or written assignments, which are manually corrected by a tutor. The main motivation for the development of this tool was to turn the paper-based assignment process into an internet-based environment to speed up the correction process. The basic drawback of WebAssign is that it does not support the formation of learning groups and teamwork. Collaborative learning is therefore not possible with this tool.

ECLAUS (Behringer et al. 2004) is also a web-based tool supporting the administration and organization of tutorials. It is based on WebAssign and overcomes the drawback of the absence of groups. Using ECLAUS, it is feasible to form exercise groups as well as learning groups. Team members can work together on an exercise and can communicate over their own group forum with each other. However, only tutors can correct students' solutions to exercises.

OASYS (Bhalerao & Ward 2001) is a web-based system for managing peer assessments. This hybrid system combines the features of self-assessment with peer assessment. The multiple-choice tasks for self-assessment are marked automatically, whereas peers assess the free response questions for peer assessment anonymously. These assessments are carried out formatively whereas the system provides enhanced functionality for assessing. This tool has no functions for grouping and working in groups. It also does not provide means for communication. Because of these drawbacks collaborative peer assessments cannot be realized.

Peer Grader (Gehringer 2000) is another web-based peer assessment system developed at the North Carolina State University. Students grade the assignments of other students summatively. With this system, the lecturer can use different reviewer-mapping strategies. On the one hand, Peer Grader can generate the reviewer mappings automatically and on the other hand, the lecturer can assign reviewers manually. With this tool, learners can resubmit their work for a second review, after correcting it based on the feedback of the first review process. Collaborative peer assessments are also not possible.

eHELp (Nückles et al. 2006) is a tool for creating learning diaries that was developed in Germany at the University of Freiburg. This system guides the writing and evaluation of entries for learning diaries. The learners can evaluate their own learning diaries as well as those of peer learners. The tool provides a working area for generating and editing learning diaries and supports functions for the planning, production and revision phases. One of the disadvantages of this tool is that it is not web-based. eHELp can only be used with Microsoft Windows operating systems. Writing collaboratively on a learning diary is not possible due to the lack of grouping functions.

All these systems were developed to support only one learning-setting. They do not provide sufficient functionality for collaborative learning. Nearly no system offers grouping functions or functions for working in learning groups. However, forming and working in groups is essential for collaborative learning. Learners solve

exercises collaboratively only with ECLAUS. Nevertheless, ECLAUS is restricted to tutorials; other learning-settings cannot be realized. Another important characteristic of collaborative learning environments is communication possibilities. All these tools, excepting ECLAUS, have no or insufficient functions for communication. Apart from Peer Grader, these systems do not provide a possibility of a second submission and review. Therefore, learners cannot react on the reviewers' feedback. But the feedback from the reviewer is only useful for the learning process when the recipients can act upon it (Topping 1998).

5. FEATURES OF FAST

To overcome the drawbacks presented in the previous section, I have developed a flexible assignment system called FAST (Flexible Assignment SysTem). The system has been developed based on the formal description of different collaborative exercises with collaboration scripts and statechart-diagrams as shown in section 3 and using the standard and open source software frameworks, scripting languages and a database system such as Tomcat, Struts, Java Servlets, Java Server Pages, Hibernate and MySQL.

The system distinguishes between the roles lecturer, student, tutor, and administrator. In the following, I describe the main use cases of FAST in more detail.

Defining an exercise with phases and assessment criteria
Every new exercise starts with the creation process of the exercise within the system. The lecturer defines the conceptual formulation of the exercise. Here he decides which learning-setting should be used. He can select one of the predefined learning-settings introduced in section 3 or define a new one. After this step, he sets up the different phases for this exercise. He can thereby configure all the phases in various privacy modes by choosing among the following alternatives: showing the name or the pseudonym of a learner, showing no information (anonymous mode) or setting the mode to user defined. In this case, the individually selected privacy mode of each learner is used, which can be full name or nickname. Furthermore, the lecturer defines a set of assessment criteria for the assessment and backward-feedback phase. He can choose various displaying forms of criteria. A criterion can be displayed to the reviewer with an input field allowing him to fill in his feedback, with radio buttons or a list of options.

Grouping
In the grouping phase, the lecturer can form the learning groups. He can select the members of the group. For tutorials, exercise groups with a tutor can be formed (Fig. 2). The created groups can be viewed, modified or deleted during this phase by the lecturer.

Figure 2: Forming a new exercise group

Creating the solution
During the editing phase, the learning groups can work together to create an artifact as a solution to the exercise. For this, each learning group can use a common workspace and an own forum. Until the end of this phase, each member of the group can update their solution (Fig. 3). For submitting the solution, an HTML form can be used or a document can be uploaded.

Communicating
Section 2 has shown the importance of communication in collaborative learning-settings. FAST provides three

forums to structure the communication. For the communication within the learning groups each group has an own, closed forum that can be used during the editing phase. To communicate within the exercise group and with the tutor, the members can use their own exercise forum. Finally for the global communication the course

Figure 3: Updating a submitted solution

forum can be used, which is accessible to everyone in the course in all phases. To further structure the communication, the type of each article must be specified.

Assigning

The lecturer selects a reviewer-mapping strategy and assigns the solution artifacts to the reviewers during the assignment phase. On the one hand, the mapping can be done automatically by the system. In this case, the lecturer defines how many reviewers should assess an artifact. In addition, he decides if the reviewers should be students, tutors or lecturers. It is also possible to combine these roles. The system takes these information into account and calculates a random assignment avoiding a self-review. On the other hand, the lecturer can assign the artifacts to the reviewers manually. It is also possible to combine both strategies. In the case of a tutorial exercise, the system assigns the artifacts to the corresponding tutor for revision by submitting the artifacts.

Assessing

In the assessment phase, the reviewers can review and assess the artifacts by using the assessment criteria. During this phase, the reviewers have the possibility to change their reviews.

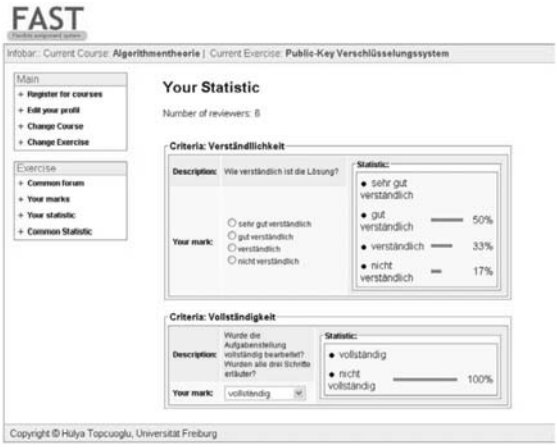

Figure 4: Statistics about the assessments of a solution

Evaluating assessments
During the inspection phase, the learners can look at the reviews of their solutions. In the case, that more than one reviewer reviewed a solution; statistics can be viewed showing the percentages how often a value of an assessment criterion was selected by the reviewers of an artifact (Fig. 4). Furthermore, all course members can view global statistics that are calculated considering all reviews of all artifacts.

6. CONCLUSION AND FUTURE WORK

In this paper, I presented an overview of various assessment strategies, CSCL, its advantages, disadvantages and some collaborative exercises. Furthermore, I described existing assignment systems and showed their limitations in the support of only single learning-setting and insufficient or non-existing functions to provide collaborative learning. On a conceptual level, I introduced two formalization methods, collaboration scripts and statechart diagrams, for structuring the learning process. According to this formalization, I presented my assignment system FAST. Unique features of FAST are the handling of different learning-settings, the flexible configuration of other learning-settings as well as single phases and the functions supporting collaborative learning such as grouping or structured communication.

In future, the usability of FAST will be evaluated in a user study. According to the evaluation results, the application will be improved. FAST will be used for a master online program in computer science at a German university next summer term. As an extension of FAST, the support of synchronous communication is planned. This can be implemented easily through a text chat, whereas the same structuring methods that are seen by the asynchronous communication can be considered. It is also planned to implement a notification service informing the users by email about the beginning of a new phase and the tasks in it.

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