

Improving Communication and Project Management through an Adaptive Collaborative Learning System*

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Abstract — *Collaborative learning is an essential aspect of the learning process but students are often faced with various issues such as unfair workloads assigned between members, not finishing assigned tasks on time, overly passive members who do not pull their own weight and overly active members who do not allow others to contribute. In this paper, we propose an adaptive collaborative learning system that focuses on improving two major aspects in collaborative learning, communication and project management, by providing advanced features as well as adaptive recommendations. By improving the communication and project management in group projects, students can learn more effectively in such collaborative settings which again improves their learning experiences overall.*

Keywords—*Adaptive Learning Systems, Computer Supported Collaborative Learning (CSCL), Collaborative Learning Systems*

I. INTRODUCTION

Collaborative learning can enrich students' learning experiences by teaching students many important skills such as communication and interpersonal skills [1]. Many researchers agree that collaborative learning is an essential part of the learning process and both beneficial and crucial if it is used properly [2][3]. However, while collaborative learning has many advantages, there are also many problems that can occur which can hinder learning and lead to a rather negative learning experience. For example, there can be times when students become left behind because they are more passive than other members, or there can be members who are too active, making it difficult for others to contribute [4]. Motivation is also an important issue in collaborative learning since when students become unmotivated they tend to not contribute the required amount of work on a timely manner, which again can be demotivating for the other members [5].

In this paper, we propose an adaptive collaborative learning system that addresses some of the most important challenges in collaborative learning, with respect to communication and project management. The proposed system, called Adaptive Collaborative System (ACS), provides learners with an advanced environment, where they can communicate in different ways with their group members, manage their project and tasks, and get personalized recommendations for individual group members and the overall group to enhance the learning experiences, aiming at

facilitating collaborative learning and making it possible for learners to benefit most from collaborative learning.

Several other works have been done in the area of adaptive collaborative learning, focusing on different aspects to support the collaborative learning process. For example, several works focus on how groups are built and aim at finding efficient ways to create groups in which learners can have a positive learning experience (e.g., [6],[7]). Another aspect that is frequently addressed by adaptive collaborative learning systems is communication and how communication in groups can be improved (e.g., [8], [9], [10]). For example, Adamson et al. [10] developed a system that uses conversational agents to encourage students to articulate and elaborate their own line of reasoning in online collaborative learning discussions. A few other systems have been developed that focus on supporting students in working together and managing their projects and/or tasks. For example, Sun and Shen's Teamwork-as-a-service implementation [6] allocates learners to specific tasks based on their learning styles.

The system introduced in this paper is different from other related works in one or more of the following aspects: (1) ACS focuses on supporting learners while doing a group project by providing adaptive recommendations with respect to communication and managing the project and its tasks, (2) ACS is domain independent, meaning that it can be used in any course for any group work in a blended or distance learning setting, and (3) ACS is designed to be integrated in any learning management system (LMS).

The next two sections of this paper describe how ACS supports communication in collaborative learning settings (in Section II) and how ACS facilitates project management in collaborative settings (Section III). The last section concludes the paper and discusses future work.

II. COMMUNICATION ENVIRONMENT OF ACS

Communication is a fundamental aspect of collaborative learning because it is not possible to work on a project with others without any discussion about the project. ACS aims at supporting communication on one hand by providing a rich communication environment to learners within an LMS and on the other hand, by providing adaptive functionalities to monitor students' communication patterns and provide personal recommendations to students.

A. Facilitating Rich Communication

ACS provides a rich communication environment that allows members to easily communicate with each other from

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a central location/page using discussion forums, chats and private messages. In addition, ACS shows members who are currently online and when other members logged in last.

Brindley et al. [5] discuss that even with a rich communication environment integrated into an LMS, students might still use other third-party tools such as email or Skype for some of their discussions. Therefore, ACS has a feature to import such third-party communications.

B. Adaptive Recommendations

While communication is essential for group work, it can also cause problems. Brindley et al. [5] discuss that sometimes there are students who struggle with communication and interpersonal skills and this affects the outcome of a group project. Other examples of communication problems could be related to students who either are very passive or overly active so that other members cannot contribute to the project.

To help students communicate effectively during their group project, ACS is considering three types of behaviour in group communication and provides adaptive recommendations to improve communication in the group respectively. In order to provide students with such recommendations, students' interactions in the ACS communication environment as well as from imported communications are tracked and used to determine communication patterns.

The first considered type of behaviour is characterized by a group member frequently not attending group meetings. To identify this behaviour, ACS calculates an average participation score, indicating how often a student attended group meetings. If the student missed more than 20% of the meetings, a popup alert is sent to the student, reminding him/her to attend the meetings in order to contribute to the group work.

The second type of behaviour involves a group member who is attending meetings but not contributing much to the discussion. To identify this type of behaviour, ACS determines how much members are contributing to each communication session (e.g., a forum discussion on a particular topic, a chat session, a Skype session, etc.), taking into account the number of messages written and the length of these messages. Based on these two variables as well as the average number of messages and the average length of messages in the respective group and communication session, the system identifies whether a student is contributing significantly less to a communication session. In such case, the student is provided with personalized recommendations from time to time based on their participation level and the communication tool used (i.e., forum, chat), encouraging them to participate in the conversations, and giving them advice on how they can contribute to the conversation. Accordingly, ACS encourages not so active students to contribute to discussions, either synchronously or asynchronously.

The third type of behaviour deals with group members who are over-active and who contribute so much that others have difficulties in contributing to the conversation. For this type of behaviour, again the number of messages and length of messages is used to identify such behaviour, in combination with the average number of messages and

average length of messages from group members in the same communication session. If a student has been identified to contribute significantly more than other group members, ACS provides this student with a personalized recommendation to involve and encourage other members of the group to participate in the conversation. The system guides this student by giving suggestions on whom to encourage first to participate and provides advice on how to best encourage other students to participate in the discussion.

III. PROJECT MANAGEMENT IN ACS

A project can be defined as a specific sequence of tasks that ultimately lead to a completion of a goal or desired outcome within a desired timeframe and specification [11]. The following sections discuss how tasks can be managed in ACS and the adaptive features that ACS offers to support learners to manage their projects/tasks effectively.

A. Tasks

In ACS, each group can either select predefined tasks (entered by a teacher) or create their own tasks to complete the project. For each task, they can provide a task name, brief description of the goal to accomplish, a start date, an end date, which members are assigned to the task, the estimated number of hours to complete the task, and the current progress of the task. The main screen of ACS (see Fig. 1) makes members aware of their progress by a visual progress bar and shows all tasks that have been decided by the group to be necessary for the successful completion of the project.

For each task, further information is provided through a task page that includes the task name and description, a detailed report about the status of the task and a progress bar, similar to the one in the main interface, indicating whether the task is on time (green) or not (red). To calculate whether a task is on time, ACS compares the percentage of time passed to complete the task, given its start and end date (e.g., 20% of time has already passed), to the progress of the task (e.g., 10% of the task is already completed). If the percentage of time passed to complete the task is higher than the progress, the task is in bad standing and the bar becomes red; otherwise the task is in good standing and displayed in green.

In addition, the task page also allows students to upload files associated to the respective task which can then be viewed and commented on by other members of the group.

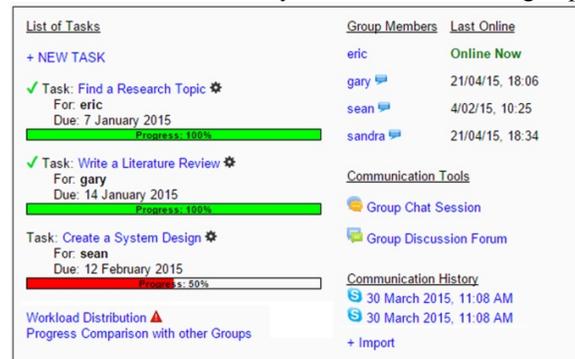


Figure 1. Main ACS Interface.

B. Ensuring Equal Workload Distribution

In every project, tasks are designed to make the project more manageable and allow for members to be assigned a portion of work that they are responsible for. However, often there can be problems when trying to evenly distribute the tasks between members, leaving some members with significantly more work and others with significantly less.

ACS has a feature that supports groups in the distribution of work between members by providing them with detailed information on their assigned workload distribution. At any time, members can click the 'Workload Distribution' link on the main ACS interface and see a visualization of hours each member should work, each member's assigned hours of work, the difference between these two, and how much this difference is in relation to the overall project duration.

The system also monitors whether there is an imbalance in the distribution of work. Whether or not such imbalance exists, is calculated by considering the hours of work assigned to each member, the overall hours required to complete the project and the number of members in the group. If ACS identifies that any member has been assigned significantly more or less work than the amount of work required for each member, ACS alerts students by showing an exclamation mark with red background behind the "Workload Distribution" link on the main ACS interface (see Fig. 1).

C. At-Risk Identification

There are many reasons why a project or task can be delayed but falling behind on tasks can seriously impact the outcome of the project and might lead to students not being able to successfully completing the project.

ACS provides groups with an overview on their progress on the main interface but then goes even one step further by monitoring students' progress and identifying the risk level of groups with respect to their likelihood of not being able to complete the project successfully due to delays in completing tasks. To do that, ACS compares the current group progress with the progress of successful and unsuccessful groups of previous cohorts in order to identify a risk level of the current group. If the current group is considered to be at risk (even if the risk is small), members of the group are alerted with a popup when they login to the LMS, making them aware that they are at risk of not successfully completing the project and providing them with more detailed information and statistics on their risk level.

D. Increasing Motivation

Motivation is an important aspect in group work. Therefore, ACS implements a motivational technique that encourages competition between groups in the class by showing students each groups' progress. This technique builds on the satisfaction category of Keller's ARCS model [12], as it allows learners to be rewarded by comparing their progress to other groups' progress. This information can motivate learners to work at a quicker pace than other groups and to continually try to improve.

To compare the progress of groups, ACS calculates the overall progress of each group and visualizes this information

to all groups and their members to make them aware of their group's standing in comparison to other groups. This information is accessible via the main ACS interface.

IV. CONCLUSION AND FUTURE WORKS

This paper introduced ACS, an adaptive collaborative learning system that provides students with recommendations to work more efficient and productive together in group projects. ACS consists of two major components, the communication environment and project management environment. ACS is domain independent and can be integrated in any learning management system.

ACS addresses some of the prevalent challenges of collaborative learning by facilitating the learning process in collaborative settings, aiming at benefitting students to get out most from working together with other students. In future, we plan to evaluate the system through a pilot study and demonstrate its effectiveness in supporting students' during group work.

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