A Diagnostic Mechanism and Tool for Analyzing Group Collaboration Problems with Online Group Work

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Abstract: Analyzing group collaboration problems for online group work has become a complex task for a teacher who is responsible for checking the progress of the group work that is examined. This is because various different methods are desirable for ascertaining the existence of different collaboration problems. Along with the increasing use of online collaboration, there is a growing need to improve the delivery methods and to simplify how teachers monitor collaborative activities. In this paper a novel diagnostic mechanism and tool are presented for supporting the analysis of major types of group collaboration problems. This research has further implications for extending existing collaborative learning environments in order to automatically monitor collaborative processes for online group work.

Introduction

Collaborative learning has become increasingly prominent in the web-based learning context, especially with recent widespread use of applications of Web 2.0 tools such as wikis and blogs. However, a number of recent studies have revealed that there are still many problems that exist with online group work and which can impede the success of student collaboration. Assessing these collaboration problems can assist teachers or moderators to understand and evaluate how individual students perform in a collaborative group as well as help students to reflect on their own learning. However, analyzing these collaboration problems is a complex task because a variety of such problems exist and distinct methods or techniques are required to support the analysis of these problems. Current applications that support online collaboration (including single tools such as forums and wikis as well as collections of tools such as learning management systems) have limited or no support for monitoring the collaborative process and thus assessing the collaboration problems encountered by individual students and collaborative groups.

Most of the collaboration problems are induced by students themselves (Liu, et al. 2010). A number of research studies in interaction analysis for collaborative activities including (Talavera and Caudioso 2004) (Jun, et al. 2005) (Bratitsis and Dimitrkopoulou 2005) have indicated that quantitative data relating to student interactions with a collaborative learning system can account for the behaviors of individual students and collaborative groups. For example, Talavera and Gaudioso (Talavera and Caudioso 2004) suggested that the number of threads started by an individual student can indicate the degree of involvement to produce a contribution.

In this paper, a diagnostic mechanism and tool are proposed for analyzing the major group collaboration problems that widely exist in online group work. This mechanism and tool attempt to address methods for ascertaining the existence of these problems based on data relating to student interactions with a collaborative learning forum. The remaining sections are organized as follows. First, a summary of the types of collaboration problems that the mechanism intends to analyze is presented. Following that, a description of the components of the

mechanism and how each component was established is provided. Finally, a tool namely GroupDoctor, which was developed to demonstrate the core research ideas that underpin the proposed diagnostic mechanism, is described.

Types of Group Collaboration Problems

Student collaboration in online group work faces various challenges. Some are caused by factors not directly related to the students, such as unclear instructional guidelines, problems inherent in virtual communication relying solely on written language, and challenges presented by working in different time zones.

However, the major challenges are student-induced collaboration problems. A recent nationwide survey in the UK (Liu, et al. 2010) has identified six major student-induced collaboration problems that exist widely in web-based collaborative group work for undergraduate computing-related courses. These problems belong to three major categories: poor motivation, lack of individual accountability and negative interdependence. A description of the six group collaboration problems relating to the three categories is provided as follows.

- *Poor motivation:* This problem refers to a situation in which the members of a collaborative group are expected to provide in-depth reflective responses to a discussion on a given learning topic or material and one of the group members posts a message that may contain several grammatical and/or spelling errors and is difficult to understand. This type of problem has also been identified in studies of online group work including (Al-Shalchi 2009) (Chang 2008).
- *Lack of individual accountability:* Three major problems were recognized. The first represents a situation in which the members of a collaborative group discuss online to accomplish a piece of group work with an asynchronous collaboration tool and an individual student does not contribute much during the online discussions. The second problem describes a situation in which a deadline is set for a piece of group work and the members need to complete the work together (no role division within the group), and one member fails to meet the deadline. The final problem occurs when each member in a collaborative group is allocated a role to complete the group work and one student does not complete his or her assigned work. These problems have also been identified in other research including (An, et al. 2008) (Herrick, et al. 2011).
- *Negative interdependence:* Two problems were identified. One depicts a situation in which a collaborative group is assigned a piece of group work and all the members wish to discuss the solutions together, however they do not provide much feedback to each other about each other's thoughts. The other denotes a situation in which the workload of a collaborative group is not shared fairly, and one student in the group does most of the work and other members do little or no work. These two situations reveal the problems faced by individual groups whose members have negative relationships with regard to collaboration. The first problem has been discussed by (Hew and Cheung 2008) and (An, et al. 2008) who noted that limited student participation in online discussion appears to be a persistent problem. The second scenario is known as the "free-rider" problem identified by Roberts and McInnerney (Roberts and McInnerney 2007) as one of the common problems of online group learning.

A Diagnostic Mechanism

The proposed diagnostic mechanism focuses on analyzing collaboration problems in group work with a collaborative learning forum. This is because forums have been identified as the most popular tool for supporting web-based collaborative group work (Liu, et al. 2010).

Before discussing the components of the diagnostic mechanism, the six types of collaboration problems identified are summarized as follows: 'not contributing much in online discussions' (CP-1), 'not actively meeting the deadlines' (CP-2), 'not actively completing the assigned work' (CP-3), 'post contains grammatical and/or spelling errors' (CP-4), 'little feedback on each other's task work' (CP-5), and 'single student dominating the group' (CP-6). The first four problems (CP-1, CP-2, CP-3, and CP-4) represent student problems that may occur, and the last two (CP-5 and CP-6) are types of group problems.

Since a variety of collaboration problems have been identified, the diagnostic mechanism contains three different kinds of methods for ascertaining the existence of these problems, which are presented respectively below.

Predictive Models: Regarding the first three problems (CP-1, CP-2, and CP-3), three predictive models

were constructed for determining the relationships between the existence of the problems and certain types of student interaction. The methodology of predictive modeling (Chatterjee and Hadi 2006) was applied for establishing the predictive models. Such a predictive model quantitatively defines the relationships between the occurrences of an event (i.e. the response or dependent variable) and the factors that can indicate the occurrences of such an event (i.e. the predictors or independent variables). Following this methodology, a data set was built which contains empirical data about the response variables representing the existence of various collaboration problems and the potential predictors. Then statistical techniques were applied for estimating and validating the predictive models using the constructed data set. The established predictive models have identified and prioritized (in terms of relative impact on the final model) the types of student interactions with a collaborative learning forum that contribute to the prediction of the existence of the collaboration problems in question. The models produced can be used to compute values of the response variables for given sets of predictors for problems CP-1, CP-2 and CP-3.

Grammar and Spelling Checker: Concerning the fourth problem (CP-4), a method for identifying grammatical and spelling errors is desired. Existing grammar and spelling checkers provide a solution for this. They can be applied in the proposed mechanism to check written texts of posts for grammatical and spelling correctness. If the content of a post is verified by a grammar and spelling checker and identified to have one or more grammatical or spelling error, it is likely that the student who created the post has the problem. The open source software 'After the Deadline' (Automattic Inc. 2009) was selected for this purpose. This is because this software checks the common grammatical and spelling errors encountered in daily uses which are considered to check the writing mechanics of students in an appropriate level in the context of informal discussions within a forum for online group work.

Diagnosis Algorithms: In consideration of the last two problems (CP-5, CP-6), two diagnosis algorithms were created for deciding whether or not an individual group has a particular type of relevant problem. For constructing the algorithms, an analysis of the problem scenarios and a further literature review were carried out to identify the indicators which are considered to be capable of revealing the existence of the two problems, such as the overall number of posts produced by a group. Also, a set of parameters was identified for each of the diagnosis algorithms. For example, the number of posts produced by a group on a group forum might be defined as "relatively few". Then, the two algorithms were developed incorporating these identified indicators and parameters. The designed algorithms require pre-definition of the incorporated parameters for the diagnostic process. In the example above, the definition of 'few' depends on the features of the group work examined such as the time period that the group work lasts for and the numbers of the posts made by other groups. The teacher or moderator, who is checking the progress of the group work that is examined, would be advised to provide the definitions of the required parameters.

GroupDoctor Tool

The GroupDoctor tool was developed for implementing the core components of the proposed diagnostic mechanism, that is, the three predictive models and the two diagnosis algorithms. GroupDoctor attempts to provide the practical components necessary to support teachers for assessing how individual students and groups perform regarding the group work examined. A description of the features of GroupDoctor is given below.

First, it provides an *authentication* functionality which controls user access to the system. Second, it encompasses a *data uploading* functionality which allows a teacher to select and upload data files (in an agreed standard data format) to the system. The data files contain the student interaction data collected for analyzing a piece of online group work. The tool offers a *configuration* functionality which allows teachers to set the values of the parameters required and a *diagnosis* functionality which takes as inputs the data files uploaded and the values of the parameters configured, and then analyzes the existence of the collaboration problems based on the diagnostic mechanism implemented. Finally, GroupDoctor contains a *presentation* functionality which delivers the final diagnostic products to teachers in an illustrative way such as using tables and diagrams.

The following scenario illustrates the functionalities that GroupDoctor provides. Jack is the teacher who organizes the group work that is examined. One day after the group work has begun, Jack wishes to assess the collaboration problems for the students and groups who are participating in the examined group work. He then opens the web browser on his desktop computer and logs in to the GroupDoctor system for starting a diagnosis task. Jack then chooses to perform a new diagnosis task and he selects the data files containing the student interaction data which are prepared and uploads them to the GroupDoctor system. Next, the system asks him to configure some parameters for the diagnosis task. Jack inputs the values for the parameters and clicks the 'diagnose' button for

executing the diagnosis process. After the diagnosis process is completed, Jack can view the diagnostic results as tables and diagrams using his web browser which are delivered by the GroupDoctor system.

Next, more detail on the tool is discussed by focusing on two of its features: the Diagnosis Setting interface and the Diagnosis Results interface. This is because they allow the originality of this tool to be demonstrated and provide an intuitive way of illustrating the process of analyzing group collaboration problems with the diagnostic mechanism.

Once a teacher chooses to perform a new diagnosis task, he or she enters the Diagnosis Setting interface as shown in (Fig. 1). This interface embodies two of the functionalities that are implemented in the tool: the data uploading functionality and the configuration functionality. On the left of the page is a list of the data files that have been uploaded to the application server. A teacher can select from those files as the required student interaction data for the diagnosis process. If no files have been uploaded, the teacher can use the 'Choose File' and 'Upload' buttons below the list to upload a new data file which has been prepared offline by the teacher. On the right of the page is a group of radio buttons for the teacher to specify the course for which the parameters are defined and a set of input boxes for the teacher to define the values for the parameters desired. After the teacher clicks the 'Diagnose' button, the client (i.e. the browser) will send out the diagnosis request and the application server will start to analyze the problems after receiving this request.

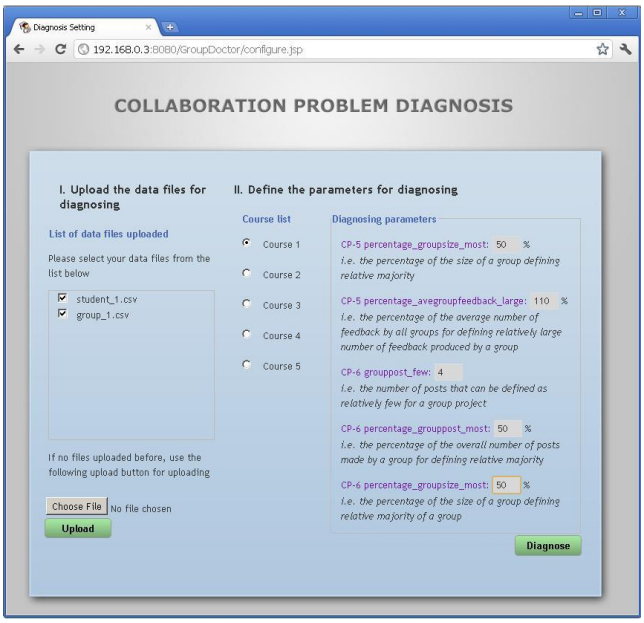

Figure 1: GroupDoctor Diagnosis Setting Interface.

After the diagnosis is completed, GroupDoctor will respond the Diagnosis Results interface to the teacher (Fig. 2). This interface embodies the presentation functionality that is implemented in the tool. Two tables are provided on the left of this web page, representing the problems for individual groups and students respectively. Five pie charts are drawn on the right of the web page. Each pie chart corresponds to the ratios of the groups or students that are identified to possess one category of the problem existence (i.e. 'Yes', 'Maybe' or 'No') to the total number of groups and students that were analyzed. For example, on the top right of this figure, the pie chart (for Problem 6) illustrates three ratios. The green segment of this pie chart suggests that 61.1% of the groups did not have the problem CP-6. The red segment indicates that 27.8% of the groups were identified to have the problem CP-6. In addition, the blue segment shows that 11.1% of the groups may have the problem CP-6. The names of the collaboration problems analyzed are noted at the bottom of this web page.

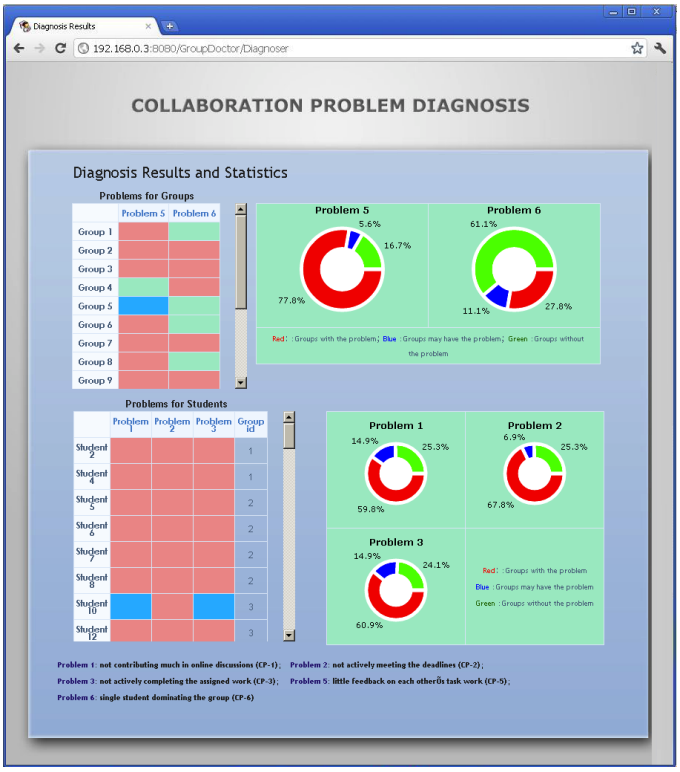

Figure 2: GroupDoctor Diagnosis Results Interface.

The GroupDoctor tool is designed as a web application since it offers much convenience for teachers to perform diagnosis tasks anywhere and anytime provided that a web browser is installed and the Internet is connected. Moreover, it allows GroupDoctor to be integrated in a web-based collaborative learning environment for supporting the analysis of group collaboration problems in future work.

A Java-based tool set was used for the development of the GroupDoctor tool. Eclipse Java EE IDE was used as the development environment for completing the programming tasks. Dynamic web content technology including JSP and Java Servlets was adopted for implementing the web application. Moreover, JSP technology is responsible for generating dynamic web pages to deliver the diagnostic functionality for this application. JSP is also used for generating the static web pages for this application in terms of user logins and configuration of the parameters for the group work that is examined. Additionally, Java Servlet technology is accountable for handling the requests from a client and dispatching relevant responses to the client in terms of authenticating users, saving the uploaded data files and conducting the diagnosis based on the diagnostic mechanism. Finally, Apache Tomcat Server was applied for deploying and running the web application.

Conclusions

Current collaborative learning environments, which are better known as LMSs (Learning Management Systems), have little or no support for teachers to monitor the collaborative process for online students in terms of the collaboration problems they possess. In this paper, a novel diagnostic mechanism and tool are presented to support the analysis and presentation of major group collaboration problems that exist widely in online group work. The determination of such problems is based on developed (mathematical) models, algorithms and a chosen tool for grammar and spell checking, as well as data relating to student interactions with a collaborative learning forum. These proposals are likely to have further applications in current collaborative learning environments for supporting automatic monitoring of the collaborative process for online group work.

The next phase of the research involves an evaluation of the diagnostic mechanism and tool. Currently, the validity of the predictive models and the diagnostic accuracy of the diagnosis algorithms are being evaluated. The

evaluation includes several experiments with a test dataset that has been collected from a web-based computer science group project undertaken in the authors' department.

References

Al-Shalchi, O.N. (2009). The effectiveness and development of online discussions. *Journal of Online Learning and Teaching*, 5 (1), 104-108.

An, H., Kim, S. and Kim, B. (2008). Teacher perspectives on online collaborative learning: factors perceived as facilitating and impeding successful online group work. *Contemporary Issues in Technology and Teacher Education*, 8 (1), 65-83.

Automattic Inc. (2009). After the Deadline: a software service for language checking, available at: http://afterthedeadline.com/.

Bratitsis, T. and Dimitrkopoulou, A. (2005). Data recording and usage interaction analysis in asynchronous discussions: The D.I.A.S. system. *Proceedings of the Workshop on Usage Analysis in Learning Systems*, Amsterdam, The Netherlands.

Chang, C.-C. (2008). A case study on the relationships between participation in online discussion and achievement of project work. *Journal of Educational Multimedia and Hypermedia*, 17 (4), 477-509.

Chatterjee, S. and Hadi, A.S. (2006). *Regression analysis by example*. Hoboken, N.J.: Wiley-Interscience.

Herrick, M., Lin, M.-F.G. and Huei-Wen, C. (2011). Online discussions: The effect of having two deadlines. *Proceedings of Society for Information Technology & Teacher Education International Conference 2011*, Nashville, Tennessee, USA, 344-351.

Hew, K.F. and Cheung, W.S. (2008). Attracting student participation in asynchronous online discussions: A case study of peer facilitation. *Computers & Education*, 51 (3), 1111-1124.

Jun, N., Shinichi, H., Kazaru, Y. and Yuhei, Y. (2005). iTree: Does the mobile phone encourage learners to be more involved in collaborative learning? *Proceedings of th 2005 conference on Computer support for collaborative learning: learning 2005: the next 10 years!*, Taipei, Taiwan, 470-478.

Liu, S., Joy, M. and Griffiths, N. (2010). Students' perceptions of the factors leading to unsuccessful group collaboration. *Proceedings of the 10th IEEE International Conference on Advanced Learning Technologies (ICALT 2010)*, 565-569.

Roberts, T.S. and McInnerney, J.M. (2007). Seven problems of online group learning (and their solutions). *Educational Technology & Society*, 10 (4), 257-268.

Talavera, L. and Caudioso, E. (2004). Mining student data to characterize similar behavior groups in unstructured collaboration spaces. *Proceedings of the Workshop on AI in CSCL*, 17-23.