Group Formation and Grading for In-class Group Activities

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Abstract: The paper introduces a system for collaborative learning which is designed to assist teachers in forming and grading groups for in-class group activities. The system is implemented as an extension of a learning analytics Dashboard and uses learning log data from BookRoll system for operation. It consists of a group formation parameter console and the results console where formed groups are visualized and can be graded. The system supports teachers by using algorithms based on reliable learning log data thereby simplifying the group formation process and save time for teachers. All the group formation results and grading data are logged thus cyclically providing an infrastructure for subsequent collaborative learning activities.

Keywords: collaborative learning, group formation, groupwork evaluation

1. Introduction

In collaborative learning students work together to complete a task or to reach team goals[1]. Nowadays, collaborative learning is increasingly significant in education since not only cognitive knowledge, but also interpersonal skills such as critical thinking, problem solving and reasoning that count in modern society. Amongst tasks that is necessary to successful in-class collaborative learning, group formation is the fundamental component since it determines quality of group work[2].

However, teachers usually take around one hour on this trivial work and might get overwhelmed when using CSCL in their teaching activities. Hence valid support for executing and managing such activities in a timely and informed manner becomes imperative. The system presented in this paper provides a solution to support teachers in group formation and analytics based on learning log data from BookRoll learning system[3]. This study will explore the following two research questions.

RQ1: How can the group formation algorithm reduce group formation time and improve groupwork performance.

RQ2: What is the difference among parameter selections depending on context and grouping purpose.

2. Related Works

2.1 Computer-Supported Collaborative learning

Computer-Supported Collaborative learning (CSCL) is an emerging branch of learning sciences concerned with studying how people learn together with the help of computers[4]. Synchronous CSCL is one application, which happens when learners engage in learning in a specific relatively short timeframe. Synchronous CSCL facilitates peer discussion, leading to metacognitive, co-regulation and social emotional activities occurring to enhance learning. Meanwhile, CSCL is a special form of ICT aimed to improve learning, strengthen educational processes and increase students' success. Achieving these objectives requires the systematic implementation of theory to educational practices from the relevant studies especially from motivation and engagement studies[5].

2.2 Group Formation

Forming a group that collaboratively learns is one of the most challenging tasks in CSCLs context. It is an atomic process that can be affected by various factors depending on the group members characteristics, the context of the grouping process and the techniques used to form the group(s) [5]. Collaborative learning with properly formed groups is found to outperform traditional teaching[6]. However, improper used group formation parameters may raise several problems that lead to failure[7].

The common topic of techniques consists in the comparation between heterogeneous and homogeneous methods and the parameters used in practice include gender, ability and personality. For example, studies have found that female learners are more for collaborative work than male learners[8]. Researches have pointed out that different grouping methods adapt to different pedagogical contexts. Studies indicated that homogenous grouping performs better in inquiry leaning context[9], while learning effectiveness of heterogeneous grouping proves to outperform that of heterogeneous one in didactic learning[10]. Meanwhile, heterogeneous groups are found to benefit learners with low ability to make greater progress.

2.3 Group Work Evaluation

The evaluation of group work is of necessity since it can not only provide a grade for the course, but also improve group work quality, help achieve accountability and give motivation during the process thus promoting individual learning[11]. The group work performance is measured by contribution to the group work, knowledge acquirement and the final product. These methods can be broadly divided into two types, summative and formative assessment[12].

Summative assessment focuses strongly on the cognitive aspects of learning, often applies a single performance score. The knowledge enhancement practiced by pretest and posttest is a typical way. Formative assessment focuses on cognitive, social, and motivational aspects of learning, which often applies a multimethod approach and it leads to a profile instead of a single score. Increasing researches focus on formative assessment for group interaction. Primarily contribution, performance, participation, and engagement often recur as the focus. Meanwhile, more self-assessment and peer-assessment are adopted since a teacher cannot monitor the whole class while the groupwork undergoing[11].

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3. System Development

3.1 Development Tools

The system introduced in the study conducts the development adopting Javascript React.js to construct the interface and Ruby Rails for the server. The system works as an extension of a learning analytics system and its dashboard application[13]. After testing and feedback from teachers, the system was launched onto the server for target school.

3.2 Structure

As is illustrated in Figure 1, learning log data is collected from educational applications such as BookRoll system, organized into student model variables which characterize students' features and stored into the analysis database. The group formation system uses the learning log data to generate groups[14]. Figure 2 shows the workflow of the system. In the beginning, teachers need to select course and students to be used as part of collaborative work. Following that, the teachers decide on the group formation parameters that best suit the concrete learning activity. During and after group work, teachers grade the performance of group work and give feedback to the students. Once groups are formed and their performance is graded, these data are used to update the student model for further learning analytics use cyclically.

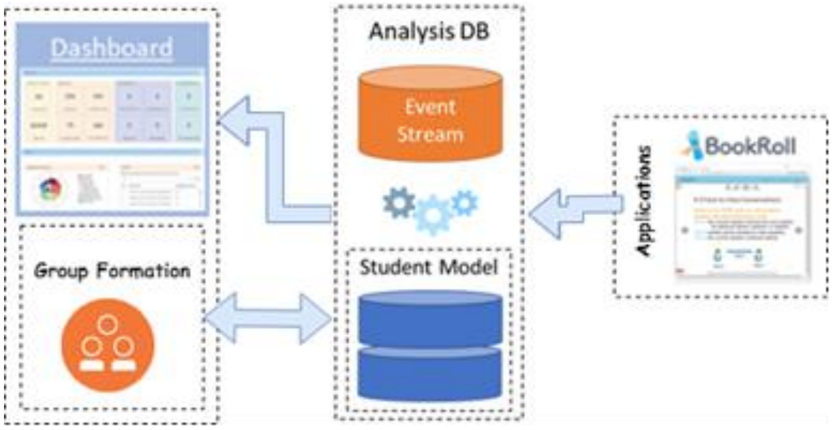

Fig. 1. Parameters input of group formation

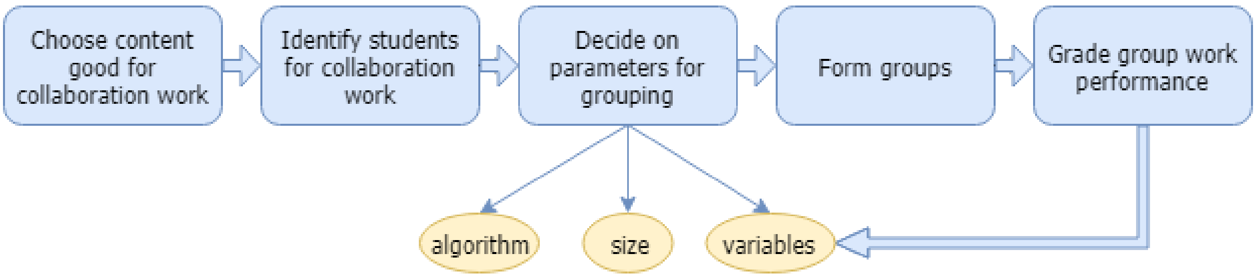

Fig. 2. The process of group formation

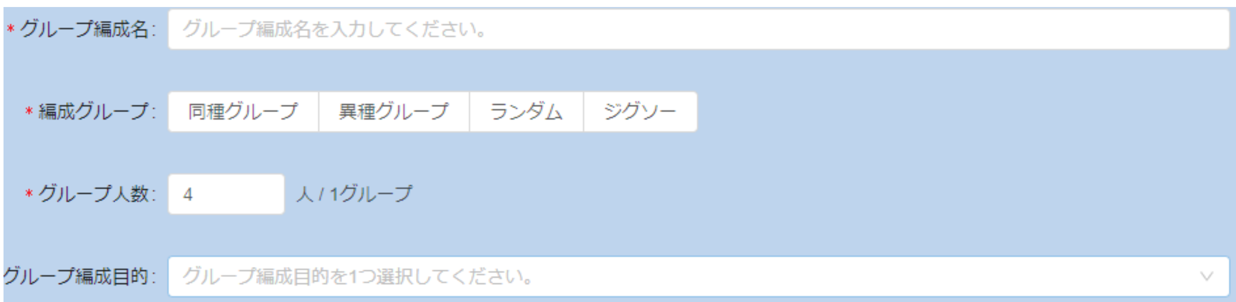

Fig. 3. Parameters input of group formation

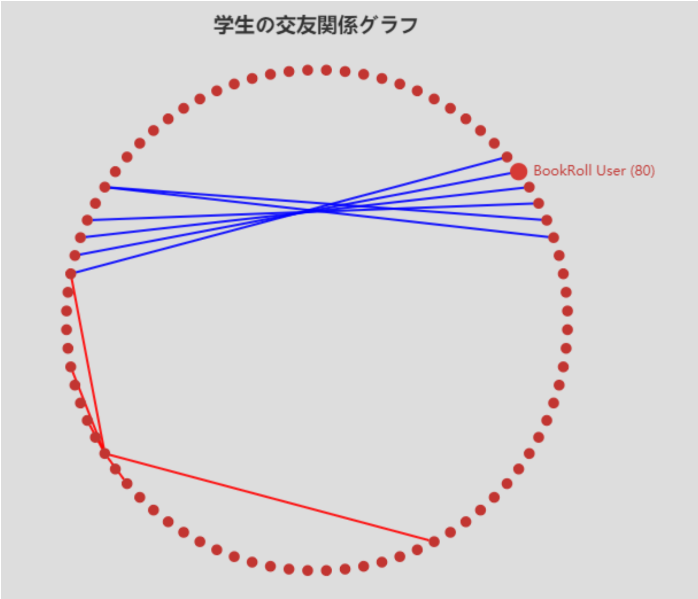

Fig. 4. Student relationship graph used by the Friendship group formation algorithm

3.3 Algorithms and Parameters

According to the latest NEC group formation survey, the academic performance, skills, attitudes and roles of the participants relative to each other counts when deciding group composition. Then the teacher can use the group formation parameter console (Figure 3) to set parameters and algorithms listed in Table I and Table II. Even there is no data, random algorithm is available. Multiple user model variables can be chosen at the same time. The system automatically gets the user model data of students from BookRoll learning log data. Besides, after setting mutual relationships between the students and getting an overview of the whole class (Figure 4), the teacher can use the Friendship algorithm. Also, it is recommended to input grouping purpose for further analysis of the optimal parameter combination in different contexts.

The homogeneous and heterogeneous algorithms used in the system coming from the idea of Hamming distance algorithm in which pairs of students are distributed orderly. Take the heterogeneous method as example, firstly, two students with the highest heterogeneity are grouped together. Sequentially, two students with the second highest heterogeneity are grouped together and then the following pairs will be selected as before.

In the experiment conducted in primary school, a special tool for expert and jigsaw in-class groupwork conduction is developed, which requires two groups with heterogeneity. The teacher should provide score data and relationship data via CSV files beforehand. Then the algorithm will first consider the social relationship based on the data table, students with good relationship will be grouped together and vice versa. Then the algorithm will assign the rest of members with heterogeneous scores within a group to favor imbalance between members of a single group.

3.4 Output and Group Evaluation

Figure 5 depicts the results of a heterogenous grouping algorithm operation. Traffic-light colors are used to give indication of previous group work Teachers can adjust the result by moving students and score the group performance for each indicator and the scores in all three indicators are stored as part of the group user model giving an overall estimation of students' collaboration performance. The metrics of the three indicators are listed in TABLE III. In the evaluation, not only summative but also formative indicators such as collaboration quality are stressed in the system. Since the evaluation should be based on the whole group work, the grade is for the whole group, not individuals. Also, the group formation result can be exported as an Excel file.

TABLE I
Algorithms used in the group formation process

Algorithm	Algorithm Operation Description
Homogenous	The algorithm groups students with similar values of a variable.
Heterogenous	The algorithm groups students with different values of a variable.
Friendship	The algorithm groups students who are friends as identified by the teacher. Uploaded CSV file is required.
Random	The algorithm groups students randomly.

TABLE II
Variables used in the group formation process

Variable	Variable Explanation
Engagement	The variable records the time student spent on using the learning platform.
Concept	The variable describes the mastery of each key concept found in academic materials of a course.
Score	The variable records previous assessment scores, including Moodle quizzes, BookRoll quizzes and uploaded CSV tables
Group score	The variable reflects students' previous performance of in group, gathered as part of group grading.

TABLE III
Metrics of group performance evaluation

Indicator	Metrics for evaluation
Collaboration quality	Interaction and communication occurring during group work, participation of members and rational division of labor
Speed / efficiency	Whether each subtask is finished on time and reasonable time management
Final output	The quality of final outputs and artefacts of group work

Fig. 5. Groups formed using the heterogeneous grouping algorithm and the color indication of collaboration performance

4. Methods

4.1 Experiment design and procedure

The RQ1 is the main issue which is planned to be evaluated by both qualitative and quantitative methods. Experiments in real class will be conducted for quantitative data. In the experiment, grouping algorithm is used as independent variable and the dependent variable is the grading given by teachers. After trained how to use the system, teachers will conduct several in-class groupwork using the system with heterogeneous algorithm (jigsaw method included) and random algorithm for comparation in the same class. Teachers are suggested to give evaluation of each groupwork for each conduction and comparative test of the algorithm and variables will be implemented.

Meanwhile, the voice of communication will be collected as objective data by devices during the class for real-time assessment of groupwork progress for teachers as well as further analysis for post hoc researches.

As for RQ2, teachers are encouraged to give grouping purpose when conducting group formation so that the optimal combination of grouping parameters in specific context can be discovered by machine learning. With accumulation of data, automatized suggestions of group formation algorithms and parameters to the teacher can be generated once selecting the identified group formation purpose.

4.2 Subjects

The first experiment will conduct in the primary school in two

Grade 5 classes in cooperation with NEC company. The class will use the group formation data for math learning using "jigsaw learning method". Besides, in high school the application of the system is planned to be conducted in math class.

5. Results

Since the experiment is still ongoing, the evaluation data and voice record is not available yet. As for qualitative results, in the light of the interview with teachers, we get feedbacks as follows.

- Unexpected combinations of students are found, which broke the teachers' prototypes.
- Some group formation results disagree with the teachers' opinion, while the performance of the groups need inspection.
- Teachers admit the positive effect of saving time for forming compared with the original manual group formation.
- There is possibility that the parameters provided may be not enough or not suitable for the group formation.

6. Discussion and Conclusion

The paper provides a solution for in-class groupwork conduction to help teacher divide students into groups efficiently for better groupwork performance. To evaluate the performance of the system, experiments in school will be conducted. Utilizing the group formation and performance data, groupwork analytics, machine learning for optimized algorithm recommendation and further collaboration applications are planned to be developed afterwards. Still, the specific machine learning algorithm necessitate further discussion.

Indeed, there are several defects to be improved. As for the algorithm, the method applied may be too easy to provide results with more accuracy. For evaluation, in the study we adopted the group assessment method that rely on teacher's assessment of the whole group's work. The disadvantages are obvious that it is hard to track each member's contribution, thus causing social loafing and free-riding. This will lead, as part of the planned future work to more focus on the algorithm and evaluation modules to prefect the system.

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Acknowledgments This research was supported by JSPS KAKENHI Grant-in-Aid for Scientific Research (S) Grant Number 16H06304 and NEDO Special Innovation Program on AI and Big Data 18102059-0.

