ABSTRACT
Project-based learning, which is a student-centered learning model imposing of more responsibility on students for their own learning than the traditional lecture-based approach, has been widely used in most of engineering courses. Albeit project-based learning courses provide engineering students with a high educational achievement and problem-solving capability, there are lot of difficulties in solving process of their projects. Above all, at the initial stage they encounter a difficult situation such as building an autonomous team to carry out their project. This study aims to develop a team-building support system (TSS) to help students construct their team in project-based learning courses. Coincidence degree-based, closeness-based and successful cases-based algorithm were applied to the TSS and can be used individually or together according to the team-based class objective. Further, the responsive web design technology applied in the system enables users to build a team regardless of time and place. Thus the TSS is expected for students and teaching staff to effectively implement their project at the initial stage.

Keywords: Project-based learning, Engineering education, Team-building support system, TSS

I. INTRODUCTION
Project Based Learning (PBL) is a representative learning method of constructivism learning theory that organizes a team, and finds a framework for solving a problem by sharing discussion and ideas to solve
practical and contextual problems through projects [1-3]. While there are many classes that apply PBL in engineering education, and they enjoy a degree of satisfaction [5], there is relatively little analysis on how they are applied to class, and whether students feel interest and face difficulty. Therefore, when recognizing the importance of PBL in engineering education, and in class-progress based on PBL, they should be strategically enabled to progress through a class, without facing difficulty.

Based on the class syllabus of the required classes of Industrial Management Engineering at HUFS, the percentage of classes based on PBL is nearly half (47%). In addition, we analyzed the feedback of 82 students who participated in the capstone design class from 2014 to 2015, and the results of a survey taken by 20 current students; student opinions regarding the difficulty of teaming in class were 74% for Capstone Design class students, and 80% for current students. This means that although half of the required classes are PBL-based, most of the students struggle with the team-formation, which is the start of the project.

In this study, we developed a system (Team-Building Support System: TSS) that enables students to quickly and efficiently organize teams. We apply coincidence degree-based, closeness-based, and successful cases-based algorithms to the TSS to help students effectively and efficiently organize their team configuration. Students can also form a team that fits the team’s personality based on the general project, graduation project, and contest. TSS is built on a reactive Web site, and allows users to use the system via the web and mobile devices. Through the TSS, we expect that professors can achieve educational goals, and students will increase their academic performance.

II. RESEARCH BACKGROUND

A. Basic Concept and Characteristics of the PBL Model

PBL based on constructivism learning theory is a structured form of learning that focuses on finding allowing learners to spend much time on finding primitive problems for problem solving and organizing problem-solving methods themselves [6]. The system implements PBL, so that learners can achieve 8 learning objectives, motivation, problem-solving skills, critical thinking skills, decision-making skills, independence, cooperative work, procedural skills and in-depth learning of subject matter. In this process, PBL actively emphasizes cooperative learning activity, problem-solving activity, activity to collect and analyze data and produce result, learner-centered autonomous activity, and learner reflection processes for developing higher thinking skills in engineering education [5]. Recently, there has been an increase in the number of attempts to use the latest technology educationally by combining PBL with the web, and case studies and educational effects are being analyzed [7]. The characteristics of the technology including the Internet and the PBL, are combined with the e-learning environment, and linkages with SNS and Open Course Ware (OCW) are emerging [8].

B. The Need for TSS Development

Based on the class syllabus of the required classes of Industrial Management Engineering at HUFS, we analyzed the classes in which the students freely teamed up to carry out a project. The classes having team projects are 18 of the 38 major classes in the first and second semesters, accounting for 47%. We then divided the 18 classes that undertook team projects into the duration of the project, and the proportion of grade reflection.

Within a total of 16 weeks, we divided the project by duration of the project - less than four weeks is a
“short-term project”, more than four weeks and less than eight weeks is a “mid-term project”, and longer than eight weeks is a “long-term project”. As a result, there were 12 mid-long-term projects out of the 18 classes undergoing the project (67%). We could confirm that the higher the grade, the higher the proportion of mid-long-term projects than the short-term projects. When the results of the team project were classified into the classes with less than 30%, more than 30% and less than 60%, and more than 60% of the grades, the average percentage of the projects was 42%. As a result, the higher the grade, the higher the reflection ratio.

Through this study, we can see that half of the major classes of the HUFS Department of Industrial Management Engineering classes applied PBL. In addition, we confirmed that the students not only had to concentrate on the project over a long period of time during the semester, but the project also provided a burden to students, because their performance on the project represented a high proportion of the grades.

Also, as a result of the analysis of the feedback of the graduation project of 82 students who participated in the capstone design class from 2014 to 2015, although 47% of students who were in the fourth grade had a lot of experience of the project, they had difficulty getting information of project participant at the beginning of the project. In February 2016, interviews of the 20 current students of the Department of Industrial Management Engineering in HUFS showed that 55% of the students had difficulty in forming a team, because they could not obtain information of the project participants [9-10]. In this study, we aimed to develop a TSS that solves these problems, and helps students to quickly and efficiently form a team.

III. DEVELOPMENT of TSS

A. Basic Concept of TSS

The TSS aims to help students construct their team in project-based learning courses, and their professor identify closeness between the students and construct a team to get positive results. Currently, students of the department of industrial and management engineering in Hankuk University of Foreign Studies have many projects in major classes. Most students encounter a difficult situation in building a team, like lack of project participant information and trouble of understanding team current status at the initial stage. However, professors randomly construct teams
according to grade and gender, regardless of team performance.

TSS support for efficient team building decision-making for students and their professor allows the construction of teams that can attain better educational effect [11].

B. System Development Methodology

The TSS interworks with the existing system the Capstone IME, which used only students in the capstone project, so enabling both the professor and students in the project-based learning course to be used. The four general procedures used to construct the system, i.e., analysis, design, development and implementation [12], are applied to develop the TSS.

The analysis as a preparatory step in order to identify the team building components includes reviews of related references, and the existing team building system. In the case of the existing system, it used the team building components as the characteristics or personality of team members [13], but lacked reliability in measurement method, and was difficult to correlate with the team performance. Therefore, the TSS used 3 team components, i.e., successful cases, closeness, and coincidence degree. In the second step, the design is related to the system structure and main function. In addition, this step includes designing the database and algorithm: successful cases-based, closeness-based and coincidence degree-based algorithms. To construct the system in the development step, we used the Windows Server 2012 as a web server, and JSP, JAVA, HTML, JAVA Script, and CSS as languages with Apache-tomcat 7.0, Eclipse (Eclipse IDE for Java EE Developers) as development tools, and Microsoft SQL Server 2012 Management Studio for the DBMS. The last implementation step in order to improve the system has a test on whether the data of the output screen is consistent with the result of algorithms, as well as debugging of the programming. Further, the responsive web design technology applied in the system enables users to build a team regardless of time and place.

C. TSS System Architecture

The TSS is divided into the inputs required by team building, algorithms and outputs according to the user and the features of a project. Projects are classified into 3 categories: capstone project, project-based learning course, and contest. In the capstone project, successful cases-based, closeness-based, and coincidence degree-based algorithms are applied. In the project-based learning course and contest, closeness-based and coincidence degree-based algorithms are applied. When a professor constructs a team in the course, the team is formed based on the sociability value calculated from the closeness-based algorithm.

First, the successful cases-based algorithm provides the matching ratio with past successful cases, to compare the similarities between current team members and the team members of successful cases in the capstone project. The closeness-based algorithm provides the matching ratio on closeness to identify closeness between recruiter and applicant [14]. If a professor wants to construct a team, the system calculates the individual sociability value from the closeness-based algorithm. The TSS enables the professor to construct a team whose sociability value provides a uniformly distributed team by the highest value of the student. The coincidence degree-based algorithm provides the matching ratio on coincidence to match information posted on the recruit notice with applicant information such as specialist ability, class information, available tool, and tag.

The Fig. 3 shows the system architecture, which was designed for the using and providing for the 3 types of users: professor, student (recruiter/applicant), and operator. The users can access and use through the
application module, and produce diverse outputs on the output module, which will be stored and managed in the DBMS module. The service module including search engine and inquiry function provides the project participant information, team current status and recruit notice.

Fig. 3 The TSS architecture

D. System Functions

The Fig. 4 shows the structure of the menu of the TSS, which has classified submenus according to the 3 types of users: professor, student (recruiter/applicant), and operator. When the user is a student, the TSS is comprised of 5 submenus: My Page, Friend Management, Recruit Notice, Team Management, and Notice. The My Page menu supports identifying and modifying the user information, such as specialist ability, class information, available tool, and tag. The second menu, Friend Management, includes each user’s friend information; and the third menu, Recruit Notice, includes recruit information according to the 3 categories of project: capstone project, project-based learning course, and contest. The student who wants to construct a team can post a recruit notice and look for team members, and the student who is looking for a team can apply to the team. The recruit notice supports the team building decision-making, such as matching ratio with past successful cases, matching ratio on closeness, and matching ratio on coincidence for both recruiter and applicant. The fourth menu, Team Management, includes each user’s team information according to the categories of project; and the fifth menu, Notice, includes notices about team building written by the professor.

When the user is a professor, they can construct a team through friend information registered by students in the Team Building menu, instead of the Friend Management menu. The Team Building menu supports the construction of team applied sociability value calculated from the closeness-based algorithm, so can be expect to produce effected educational effects.

The menu Upload Attendance Book operator can manage class information of the student and support the student in identifying 5 specialist abilities in industrial engineering: OR, Production/Physical Distribution, System Analysis, Information System, and Quality.

Fig. 4 The menu structure of the TSS

E. TSS Used Examples

The main users of TSS are students who are classified into recruiters who are looking for team members, and applicants who are looking for teams. We describe the process by which a student constructs a team through TSS. First, the recruiter posts the recruiter notice, including title, recruitment period, volume of recruitment, requirement specialization ability, available tool, etc. The Fig. 5 shows the screen of posting the recruit notice.
Second, the applicant can identify recruit information arranged in order of suitability in the recruit notice menu. The Fig. 6 shows the screen of the detail recruit notice, which is comprised of the content of the project, and the matching ratio displayed as a graph.

Finally, the recruiter can identify the status of application, and check the matching ratio, while constructing the virtual team, including the applicant. If the recruiter is satisfied with the virtual team [15], the recruiter can send a message that requests team building to the team member in the screen of the request management, see Fig. 7. When all team members agree with the virtual team, the applicant can be a team member.

Fig. 5 The screen of posting the recruit notice

Second, the applicant can identify recruit information arranged in order of suitability in the recruit notice menu. The Fig. 6 shows the screen of the detail recruit notice, which is comprised of the content of the project, and the matching ratio displayed as a graph.

Fig. 6 The screen of the detail recruit notice

Finally, the recruiter can identify the status of application, and check the matching ratio, while constructing the virtual team, including the applicant. If the recruiter is satisfied with the virtual team [15], the recruiter can send a message that requests team building to the team member in the screen of the request management, see Fig. 7. When all team members agree with the virtual team, the applicant can be a team member.

Fig. 7 The screen of request management

IV. CONCLUSIONS

The purpose of this study is to develop a TSS that helps students who otherwise have difficulty in organizing a team construct a team quickly and efficiently. TSS applies coincidence degree-based, closeness-based and successful cases-based algorithms to help students effectively and efficiently organize their teams. Also, students can form a team that fits the team’s personality based on the general project, graduation project, and contest. TSS is built on a reactive Web site, and allows users to use the system via the web and mobile devices.

Through the TSS, we anticipate that the professor’s educational goals will be achieved, the learners’ academic achievement will increase, and we have confirmed the supplement points. In the Coincidence degree-based algorithm, there is a limit to show the success-matching rate of applicants based on students’ major classes. This is because the required major classes are 10 out of the 19 major classes of the Department of Industrial Management Engineering in HUFS, so there is no significant difference in similarity. Also, when a professor wants to build a
team of students based on the sociability of the students, the closeness-based algorithm is difficult to utilize, unless a student network is formed. This will be supplemented later.

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V. REFERENCES


