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USING GUILD-BASED GROUP LEARNING IN TECHNICAL COURSES

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Abstract *— Employers and accreditation boards have increasingly stressed the need for graduates who can work well in teams. However, in the traditional computer science and engineering curricula, specific group skills are not taught except in a sink-or-swim fashion. This paper presents guild-based group learning as a method for teaching teamwork skills in project-based courses. Guild-based group learning organizes guilds based on students' self-identified skills and draws team members from each guild. It has been used in the biological sciences for term-length group project work and was successfully transferred to a more applied approach in a computer science course. As with other methods of group work organization, this method allows for independent and inter-dependent evaluation of student work. This paper provides an overview of the guild-based method with tips for implementing the method in computer science and/or engineering courses.*

Index Terms — collaborative learning, group work, teamwork skills, computer science education, computer engineering education

INTRODUCTION

Employers and accreditation boards have increasingly stressed the need for graduates who can work well in teams. Feedback from employers and business advisory boards often stresses the need for teamwork skills that compliment technical skills. ABET engineering accreditation criteria specifically emphasize the ability to function on multi-disciplinary teams [1]. While one way to give students experience on multi-disciplinary teams is to throw them into project teams with specific technical outcomes, this may not be the best way to cultivate the ability to work well on a team. Given the need for graduates with effective teamwork skills as well as technology knowledge and the ability to learn, our responsibility to our students includes teaching these skills. Additionally, these skills are most effectively learned in a technical context. By identifying the specific skills that are involved with working on a team, addressing them in classes, and rewarding students for learning them, it is more likely that students will develop the ability to work well in teams before they leave their academic careers.

This paper presents a specific method for incorporating the teaching of team skills in a technical course. While the emphasis of the course is still on the technical content, guild-based group learning provides a framework for discussing team skills in classes and supporting the development of these skills.

Guild-based group learning was first presented by Wright and Boggs [6] for use in cell biology education on term-length projects. This method was applied with success in a junior-level systems analysis and design course for computer science, computer engineering and computer information science majors. Four guilds are defined early in the course that relate to specific roles in groups. Students become members of a guild based on self-identified skills that they bring to the course. Project teams are created by selecting at least one member from each guild. The guilds become support groups for students as they work in their project teams, meeting more frequently at the beginning of the term to reinforce positive skills and brainstorm solutions to problems that arise. Guild meetings provide a forum for developing teamwork skills adjacent to the development of the technical skills in project teams.

This paper first presents background information about teamwork in classes including key points for the successful implementation of any group learning method. This is followed by a description of the methods for implementing guild-based group learning, as well as showing how the particular implementation described here addresses the key points. Results are presented in the form of student feedback and tips for successful use of this technique.

BACKGROUND

Teamwork skills include the ability to communicate with and listen to others in the group, to negotiate conflict, to make decisions, to come to consensus, and to manage time and tasks. These skills are enhanced when members are aware of team dynamics and have strong social and interpersonal communication skills. While teamwork skills are valued in industry, group learning has its own benefits for students. When working together, students can accomplish more than they could on their own. Group work, even when informal, results in improved learning for students as other students introduce new perspectives to problem solving. Additionally, creativity is enhanced by the ability to brainstorm. Especially in the context of a term-length project, undergraduate work can resemble graduate-level work when multiple students contribute to a project. Along with increased achievement, students learn how to learn about their technical field while working on term-length projects. When group learning is not set up well, not only do students not receive the benefits, they become resistant to future opportunities for group work.

There are guidelines for effective group work, particularly those developed by Johnson, Johnson and Smith

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[3,4] and others described by Davis [2]. Many of these can be addressed when setting up a course and planning course projects at the beginning of the term. The key components for successful implementation are to first plan for the set up of the group work before it begins. Secondly, the group work itself should be valuable and motivated by the objectives of the course. Thirdly, the number of members in any group should meet the needs of the project while allowing all members to be busy, thus avoiding the problem of students not contributing but still receiving a good grade. Given these, the goal is to set up the work so that student interactions are both effective and positive. According to Johnson, Johnson and Smith, there are five criteria for successful group experiences. These criteria revolve around how the members interact and give guidelines for structuring the group work so that these interactions are more likely to happen in a positive way. The five elements (taken from [3] and adapted by [5]) follow. The bullets are examples of how the elements are supported within group work.

Group members must share positive interdependence.

- A common goal
- A common stake in the outcome
- Common resources
- A common understanding of each member's role

Group members must work together as individuals.

- Helping each other to work efficiently and effectively
- Exchanging important information and materials
- Providing feedback to improve future performances
- Challenging members' conclusions and reasoning to encourage better thinking and a higher-quality end product
- Promoting group goals

Group members must have individual accountability and personal responsibility.

- Accepting responsibility for his or her share of the group's work
- Demonstrating his or her personal mastery of the material produced by the group

Group members must use interpersonal and small group skills.

- Communicating accurately and unambiguously
- Accepting and supporting each other
- Resolving conflicts constructively

Groups must evaluate their process.

- Evaluating frequently how well they are functioning and making changes to improve work in the future
- Maintaining good working relationships among their members
- Facilitating the learning of cooperative skills
- Ensuring that members receive feedback on their participation
- Encouraging members to think about how the group is functioning.

How can group work be set up so that all five elements are present? These elements need to be built into the structure of the project. Rewarding students for success in all elements is key to insuring group work success. Instructors should both effectively design assignments and keep track of how groups are working to encourage this. Any teacher setting up group projects is encouraged to seek out resources beyond this paper as well. (See the appendix for further suggestions.)

While this paper focuses on formal, term-length group learning as a way to teach teamwork skills, students still receive the benefits of group learning in short-term and informal situations. Examples are informal or formal study groups and group-based problem solving in lecture or recitation sections. The motivation for students to participate in short-term work is often simply the possibility of a better grade on an exam or a deeper understanding of a new concept.

METHODS

Given that group work is useful for enhanced student learning, the specific goal of this work is to facilitate discussions of group work skills so that students can learn how to be good team members. While the method of guild-based group work takes some time during class, the set up allows project group time to be more effective for learning technical skills. A guild is defined as an association of persons of the same trade, formed to protect mutual interests and maintain standards. In this method, guilds are used to support the development of teamwork skills.

Guilds (and optionally project teams) are built within the first week of class when the class has a semester-long project. Each student is a member of two groups: a guild and a project group. Membership in guilds depends on a student's self-description of strengths. The four guilds are organized as follows: "1) an administrator guild that organizes team efforts, 2) an artist guild that helps the team think creatively, 3) a communicator guild that facilitates interpersonal interactions among team members, and 4) an expeditor guild that steps in and performs functions as needed" [6]. Project teams are then organized with one member from the administrator guild and members (possibly more than one) from each of the other guilds. This results in project groups of four students, which is large enough to complete a big project but not so large that students find themselves with too little work to do.

When forming guilds, every student is asked to give one word that best describes him or her. If a student is unable to think of one, they can be asked to give a word their friends would use to describe them. These words are then organized on the board in four columns without telling students what the columns mean. The number of students in the

administrator guild should equal the desired number of teams. Examples of words and their associated guilds are shown in Table I. Note that some words could be used to describe multiple guilds. The instructor can select the guild that makes the most sense in order to insure balanced guild members. Sometimes a student's first word choice might be clearly one guild when that is full. A request for a second word is reasonable and appropriate since every student will bring multiple skills to their project group.

TABLE I
EXAMPLES OF DESCRIPTIVE WORDS AND THEIR GUILDS

Administrator Guild	Artist Guild	Communicator Guild	Expeditor Guild
Organized	Creative	Friendly	Well-rounded
Task-oriented	Theatrical	Easy-going	Flexible
Focused	Original	Kind	Meticulous
Determined	Innovative	Sociable	Responsible
Efficient	Artistic	Diplomat	Reliable
Practical	Designer	Good Listener	Hard-working

After the guilds are formed, the rest of the class period is spent within the guilds discussing the following:

- a guild name and motto (and optionally a logo),
- what positive skills will people with attributes like those in this guild bring to a group,
- what are less positive (even negative) qualities that people in this guild might bring to a group.

The guild members will typically arrive at a description of their guild that comes close to the guild names used here. By identifying the guild for themselves rather than having the instructor name a group the "artists" for example, students are more likely to feel connected to their guild. At the end of the class period, a full-class reporting of these qualities will typically lead to a discussion of how positive qualities from one guild might balance the difficult qualities of another guild. It is important to note that all of these skills are valuable to the group but are not directly connected to student abilities to do the work of the course. After the guilds have been formed, project groups can be generated. During the semester, guilds can be used as a support network for discussing the interpersonal and small group skills they are developing. Guild members will often have similar difficulties within their project groups. Guild meetings allow for brainstorming of solutions to problems within groups. Early in the term, using some class time for guilds to check in with each other will help support the positive development of project group relationships. Guild meetings during class can be monitored by the instructor.

A class discussion about what groups can do to set themselves up for success is beneficial. Brainstorming necessary things like motivation, communication, responsibility and scheduling before project groups are constructed gives project groups a framework for discussing how their group will accomplish these things. Since students brainstorm without knowing who is on their project team, the process is constructive and collaborative.

The formal definition of guilds as organizations that support the careers of their members can be used to motivate time spent on career preparation exercises such as evaluation of resumes and cover letters within guilds. This connects to the concept of professional service organizations and develops the idea of professional collegiality and support. When done during class time, these exercises can promote a supportive atmosphere within the guilds that is useful for informal or out-of-class interactions within the guilds.

Guild-based group learning addresses the five components described earlier in the following ways.

Group members must share positive interdependence: Because the groups are assigned a large project that represents a significant portion of their grade, interdependence is assured. There is an initial sense of independent roles because groups are compromised of guild-members.

Group members must work together as individuals: By assigning a large project that requires more work than a single student could possibly do, students have to contribute to the project for it to be a success. By stressing the need for communication during the development of project groups, sharing of information within the teams is encouraged.

Group members must have individual accountability and personal responsibility: By including independent grading of some components as well as having different members of the group describe group progress to the instructor, the need for all project members to understand what is happening in a team is reinforced.

Group members must use interpersonal and small group skills: By spending much of the course working on a single project, groups will have to resolve conflicts in a way that allows them to continue working together. Oral and written communication can be reinforced by assignments and supported by guild interaction.

Groups must evaluate their process: Project grading should include evaluations by all members. Including team member evaluations in a small portion of an individual's grade reinforces this as well. Soliciting feedback from project group members and then passing that on as anonymous feedback encourages evaluation and allows for an additional communication channel that can be monitored by the instructor.

RESULTS

This section describes the outcomes of a specific implementation of guild-based group learning in a particular course. The course was a second or third-year course in systems analysis and design. The key objectives were learning how to analyze a system, identify improvements and design a new system with a technical solution. This course is used as an introduction to upper division database courses so the systems addressed in the course are information systems that can be addressed with databases. Key topics include project management, interaction with

clients, and documentation. While group skills are not a proscribed outcome of this course, it is traditionally a course with a large group project. Students leaving the course are expected to have group work experience that will inform group work in upper-division courses.

As described earlier, guild meetings are set up and held before project groups are created. The minimum number of students for this method is 12, giving four guilds with three members each and three project groups of four students. It should easily scale to much larger classes (and has as in [6]). Given a set of students, it is best to create groups whose schedules mesh when possible. Scheduling conflicts, something that would not be a problem in industry, is a major difficulty for student groups. Reducing scheduling conflicts where possible will help reduce group conflict. When scheduling conflicts are unavoidable, this can be used as an opportunity to talk about different methods of communication besides face-to-face conversations, such as email, message boards, or conference calls. Submitting weekly written updates keeps students aware of documentation but also lets the instructor keep track of any possible conflicts that might not be addressed by students. All updates were initialed by each student to show that members were aware of the progress and the problems of that week.

Periodically, students were asked to be reflective about their contributions to their project groups. A final summary of their experience working on a team was part of their final exam grade. By writing about their experiences and documenting their technical projects, the students were rewarded for doing work to develop their teamwork and communication skills.

Through anonymous feedback, many of the students in the class found that working with the guilds and brainstorming group work strategies were beneficial to their project. Students also expected that their experience working with their groups in this class would positively affect future group experiences. Students were able to articulate concrete plans for improving future group work illustrating the benefits of reflecting on their experiences. Guild-based group learning worked well in part because it facilitated conversations about communication within groups and about the non-technical aspects of the course. An additional benefit is having ready-made groups for doing short-term group work in class.

SUMMARY

An important goal for students in technology, computer science, and engineering is to leave their undergraduate educations with skills in teamwork that complement their technology skills. Teamwork skills can be taught at the same time that technology skills are developed. This paper has presented one method that allows students to learn how to learn in their respective fields by focusing on an interesting project while developing teamwork skills that will make them valuable employees in the future. While many uses of group learning in courses can enhance student learning, guild-based group learning allows students to develop teamwork skills along with their technical skills.

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[5] The Office of Instructional Consulting at Indiana University, "Basics of Collaborative Learning", <http://www.kelley.iu.edu/icweb/TL_Library/collablearnbasics.cfm>.

[6] Wright, R. and Boggs, J, "Learning Cell Biology as a Team: A Project Based Approach to Upper Division Cell Biology", *Cell Biology Education*, 1, Winter 2002, pp. 145-153, <http://www.pubmedcentral.nih.gov/articlerender.gcgi?Artid=149487>.

APPENDIX: WEB RESOURCES

Here are some recommended resources for finding out more information about group work and collaborative learning.

- The Cooperative Learning Center at the University of Minnesota, <http://www.co-operation.org>.
- Lori Breslow, "Teaching Teamwork Skills", Teach Talk Articles in the MIT Faculty Newsletter, January/February 1998 and March/April 1998 <http://web.mit.edu/tll/published/teamwork1.htm>.
- National Research Council, *Engineering Education: Designing an Adaptive System*, 1995, <http://books.nap.edu/books/0309052785/html>.
- The Center for Instructional Development and Research at the University of Washington, and their page on group learning, <http://depts.washington.edu/cidrweb>, <http://depts.washington.edu/cidrweb/GroupTools.htm>.