Teaming in Freshman Design Using a Studio Teaching Approach and Blackboard®

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Abstract

This paper describes the use of the Studio Teaching pedagogical approach, which was first developed at Rensselaer Polytechnic Institute, to teach an Introduction to Design course at Humboldt State University. The course is taught in a recently renovated Design Studio; a classroom that has computers, white boards on all walls, and moveable furniture so students can easily work in groups around computers or tables or listen to a traditional lecture. The class format is split up into small lectures interspersed with related group activities to teach teamwork, ethics, project management, spreadsheets, Computer Aided Design (CAD) and the design process. The paper will present examples of how the Studio Teaching approach is used to teach some of these topics with a focus on design and teamwork skills. Students work in teams on two projects, a 3-week Rube Goldberg device and a 10-week service-learning project for a local K-12th grade teacher. Students are assigned to teams and required to use the Blackboard group discussion board area to submit weekly progress reports. Each week, students participate in a creativity/teamwork exercise. These activities will be described in the paper. Students evaluate their peers' teamwork skills at mid and end semester via web based software. This work is funded is partially with an NSF Course, Curriculum and Laboratory Improvement (CCLI) Grant Award 0127139**.** A description of the creatively/teamwork exercises as well as the lessons on design, ethics and project management will be made available at http://www.humboldt.edu/~eae1/CCLI02/.

Introduction and Course Description

Faculty members in Humboldt State University's (HSU) Environmental Resources Engineering (ERE) program are revitalizing an introductory course, ENGR 215: Introduction to Design, to improve the retention and recruitment of students into environmental resources engineering. This paper reports the curricular changes which minimize the use of lecture to teach design and teamwork skills. In addition, the paper describes how BlackBoard is used to summarize group in class discussions as well as summarize group out of class discussions via weekly progress reports.

Course Description

ENGR 215: Introduction to Design is required by Environmental Resources Engineering Majors at Humboldt State University. The course has the prerequisite of ENGR 115: Introduction to Environmental Science and Engineering and a corequisite of Calculus I. Freshman engineering students are strongly encouraged to take ENGR 115 their first semester on campus and ENGR 215 their second semester on campus.

The ENGR 215 course has been redesigned as part of an NSF CCLI Adaptation project, with the objective to improve student interest and retention in the major. The main content of ENGR 215 has remained the same as the previous introductory design course (ENGR 111: Introduction to Design, which is described in[1]), however the delivery of the content has been changed so that the pedagogical approach is similar to the Studio Teaching Approach. In addition, prerequisites were added (ENGR 115 and Pre-Calculus) so that students could incorporate a more in depth analyses into their design projects and would be more committed to the program before taking the course. The course has a strong teamwork skill component and the engineering faculty expects that the team experiences of students are improved when students who are more committed to the program are part of the course. Blackboard is used in all portions of the class.

The course objectives are:

- Students will learn about and experience the engineering design process.
- Students will build on computing skills introduced in Engineering 115. These skills include: word processing, spreadsheet programming, graphics, Computer Aided Design (CAD), and Internet use (World Wide Web research, file transfer protocol (ftp), web page design and email).
- Students will continue to develop the many communication skills needed by practicing engineers. These skills include: written communication, verbal and visual presentation skills, and teamwork
- Students will continue to develop an understanding of ethical practices expected of a practicing engineer.

Each semester up to 30 students are split into design teams of 3 to 4 people to develop the skills listed above in the context of two design projects. The first project is an unstructured 3-week Rube Goldberg design project based on a project used at UC Boulder[2]. The second project is a 10-week client-based project.

Rube Goldberg Project

Students are assigned to a group based upon self-reported skills they submit via a "Personnel Profile". The instructor tries to insure that at least one hands-on person is part of the group as well as one person that enjoys facilitating/leading others. In addition, the instructor attempts to avoid placing underrepresented individuals (e.g. women and minorities) alone in a group.

Each group is given the following design goal:

> *Design and construct a "Rube Goldberg" machine that will crush an aluminum can while utilizing a number of interesting and innovative steps.*

Students are invited to learn more about Rube Goldberg[3]. Students are provided design restrictions that include maximum cost, a minimum number of Rube Goldberg steps, as well as time and space limitations. A basic starter kit is provided to the students for their projects. Students are expected to pay for additional materials needed for the class. (Currently, no textbook is required for the class). Students are given three weeks to complete the design and construction. They are provided little instruction or guidance for the design process or for teamwork skills. After 3 weeks, the projects are tested and judged. Each team must provide a

one-page analysis of one portion of their machine. However, no other documentation of their design is required. Students then submit a peer evaluation to the instructor summarizing their experience. The peer evaluation and project is 8 % of their final grade. Handouts describing the complete assignment are provided on our NSF CCLI Project Website[4].

10-Week Formal Design Project

During the 5th week of the semester, students are re-assigned to teams of 3 or 4. They are provided a client and a design project. Often the clients are local K – 12 school teachers and the students are required to design a device to assist the teacher's instruction of a topic related to environmental resources engineering. For example, in the Fall 2003 semester, students were asked to design a physical model that demonstrates principles of energy conservation or renewable energy generation.

This project is managed very differently. Students receive instruction on the design process. Students also receive instruction on teamwork skills and are provided structure for managing their teams. At the end of the semester, students present their design concept and a demonstration at a poster session that is open to the public and their clients attend. They also submit a formal 30-60 page design document and submit a peer evaluation. Their design project is 50% of their final grade and their peer evaluation is 15 % of their final grade. The peer evaluation process used in ENGR 215 is described extensively in previous papers [5, 6]. The final design project is donated to the client at the end of the semester.

Studio Teaching of Design and the ERE Design Studio

In 1988, Rensselaer Polytechnic Institute integrated technology into a cooperative learning environment[7] through the Studio Teaching approach. This approach integrates lecture, laboratory, and recitation by exploiting computer-based materials as a tool to accelerate, integrate, and leverage interaction. Studio courses engage students in various problem solving and active learning sessions and help students to construct their own understandings of course concepts. The integration of lab work directly into the course makes the lab work more relevant and ensures that the lab and course materials are in step. Evaluations conducted by Wilson[7] demonstrate that students learn the material better and faster when compared to the traditional science courses. Additionally, students' attitudes towards science improved and both students and faculty enjoyed the material[8].

The Studio Approach requires that one has a facility that can accommodate students working in groups about computers, with input from a faculty member. The Environmental Resources Engineering Design Studio[9] was created for such a purpose. As shown in Figures 1 and 2, the ERE design studio can be configured for traditional lectures or for group work using computers.

Using the Studio Teaching approach in Introduction to Design, the students experience instruction in a more interactive way. For example, traditionally, in the past, students might listen to a lecture describing design restrictions and design criteria. Now students are quickly introduced to the concept, and then are asked to work in groups to develop an example of that concept and submit their work on Blackboard for the class to review as a group. For example, rather than be lectured in detail on the difference between a criterion and a restriction, students are provided a quick overview and then asked to work with their teams develop the appropriate

criteria and restrictions for a provided example. They submit their answers on Blackboard in the Discussion Board area and the class reviews the work together.

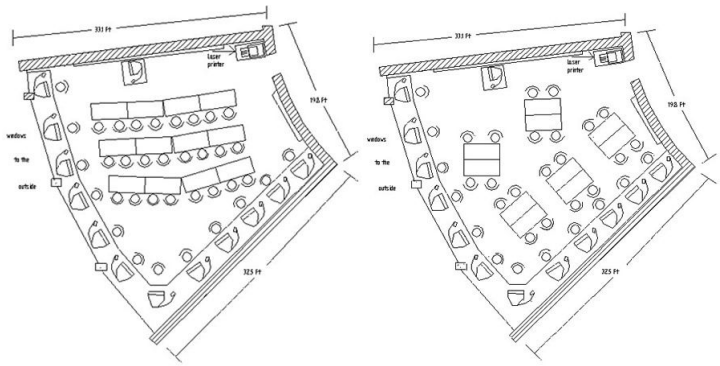

Figure 1 Diagrams of ERE Design Studio in traditional and group work layouts (drawn by Jason Fagette, ERE student, 2001).

Figure 2 Students working in the ERE Design Studio in both the traditional and group work layouts.

Teamwork and Creativity Skill Development

The course provides bi-weekly Teamwork/Creativity exercises. These exercises are still in development; however the current list of topics is provided below. Detailed explanations can be found on the CCLI Project website[4]

- *Learning Style Assessment*- Students learn about their own learning style via a number of paper and web based instruments. They reflect on how their own and others' learning styles can impact teamwork.
- *Teamwork Criteria* – The second week of class, students work in groups and are asked to submit their criteria on Blackboard for a team member to earn a grade of an A, B, C, or and F. Each group then presents their criteria to the class. This discussion provides a type of class contract for understanding how team members will be evaluated.
- *Simulation – Oblisk*[10]- This simulation requires students to work in teams to solve a problem. Each team member has information that others do not. The problem requires the team to decide which information is required to solve the problem. *Information can only be shared verbally.*
- *Couch Potatoes and Hitchhikers Reading*[11] *and Discussion* – Students discuss a reading that provides advice for students working on group projects.
- *Yes And vs. Yes But* – In small groups students take turns telling a story with each person adding one sentence. The first time the story is told, students start each

sentence with "Yes, AND…". The second time they tell a story, students start each sentence with "Yes, BUT…".

- *Stages of Teamwork Jigsaw*[12] – Students become experts in one aspect of teamwork dynamics with a group of students. They then meet with other students and teach their aspect to the new students and learn about other aspects from the other students.
- *Simulation - Desert Survival*[12]– Students individually and then in groups rank a list of items in the order of importance for surviving in the desert. The groups then compare their results to an expert's ranking to see if the group was able to improve upon the individual's rankings.
- *Team Contract Development* – Each team is responsible to submit a team contract the first week of team assignments. Students are provided time in class to work on this task.
- *Brainstorming* – Before beginning the brainstorming phase of their design projects, the class is lead through a brainstorming activity.
- *Running Effective Meetings Jigsaw* – Each team member completes a different assigned reading from a professional organization's website on running effective meetings. Then the team discusses each reading and submits on Blackboard what aspects of the readings were found useful and which will be implemented during the semester.

Team Management on Blackboard

In ENGR 215, student design teams are provided a group area in Blackboard that is only assessable by the team members and the instructor. Students have access to a team discussion board as well as a team file exchange area.

As part of their 10-week formal design project, students are required to submit weekly progress reports. Design teams' weekly progress reports are required to contain information on attendance to meetings as well as follow through on assigned tasks. Appendix I contains the template students are expected to use in their progress reports.

Some teams used the discussion board area to communicate with team members and with their client. Teams were able to request that their client be given Blackboard access to the class area as well as to the specific team area.

Design team students use the group file exchange area to save backups of drafts of their design document.

Observations

As the CCLI project is still in progress, we do not report formal assessment data at this time. Below are observations after the first semester implementing the Studio Teaching approach in ENGR 215 Introduction to Design.

Instructor

Using the Studio Approach requires that the instructor lecture less and cover less material. However, the students seem to have a better understanding of the design process material, as they are asked to act upon it immediately and they are able to get their questions answered at the

time the information is introduced. They also seem more engaged and seem to find an already enjoyable class, more enjoyable. These comments were collected by HSU sponsored midsemester evaluations.

The use of Blackboard has had two positive impacts on team processes: 1) Students submit more weekly progress reports than they did in the past and 2) Students seem to have fewer problems losing files associated with the project. In the past, these progress reports were emailed to the instructor. Most teams submitted 5-8 of the 10 required reports. This semester almost all teams submitted all 10 required reports.

Over the years, introductory students begin college with more and more computer skills. Students seem to have fewer file management problems. However, the use of the team file exchange area seems to have reduced the number of lost files that occurs each semester. In addition, the group area has allowed students to work on their documents asynchronically, so not all team members need be at working sessions. The use of the group file area also avoids the problem with one student becoming the "keeper of the project" where other students are not able to work without that student being at a given meeting. Though it is too soon to tell, as the class has only been taught once with this format, it is possible that this file sharing ability reduced the likelihood that one person would take over the team.

After this first semester with more advanced students, the design projects were more complicated and ambitious than previous semesters. In addition, this particular group of reports were the best formatted. Again, it is too soon to tell if these changes were a one-time occurrence or have to do with the population and the way the class is taught.

Student Comments

Teamwork and creativity exercises were better received by the students than expected. At the end of most exercises, students were asked to complete +/Delta evaluations, where they stated one positive (+) aspect of the exercise and one that they would change. These surveys showed the students were very receptive and willing to take risks that some of the exercises required.

Some students view the weekly progress reports as busy work. At the end of this past semester, one team had difficulties and one member discussed with the instructor that amongst his teammates they had agreed to "cover each other" in the weekly progress reports, by not reporting tardiness and/or absences or lack of follow through in action items. The student said he realized now that the purpose of the progress reports is to maintain some accountability. He felt that his team might have had fewer problems if they had taken the progress reports more seriously and that he intended to use progress reports in future team projects.

Summary and Conclusions

This paper reports the curriculum changes made to an Introduction to Design class at Humboldt State University. These changes have focused on making the class more interactive by using the Studio Teaching approach first implemented at Rensselaer Polytechnic Institute[7]. This approach uses mini-lectures interspersed with student activity. Technology is integrated into the course via Blackboard. Students use Blackboard to summarize class and out of class activity including weekly teamwork progress reports. After 1.5 semesters of implementation, the pedagogical

change seems to be a success. (However, we await formal assessment studies to be complete before drawing any major conclusions). Students seem to be learning the design process material better, they are managing their teams and documents better via the use of Blackboard. Overall, an already enjoyable class seems to be more enjoyable. Supporting course documents, including assignment handouts, PowerPoint slides and relevant URLs are available for others' use at the project web site[4].

Acknowledgements
This work is partially funded by the NSF Sponsored CCLI Grant No.DUE-0127139. The authors thank the reviewer for the constructive comments to improve this paper.

References

[1] Eschenbach, E.A. (1996) "WWW Page Design: Projects for Introduction to Design for Environmental Engineers", Proceedings for Frontiers In Education 1996 Conference, Online: http://fie.engrng.pitt.edu/fie96/papers/333.pdf, viewed January 9, 2004.

[2] Bedard Jr. A.J. (1999) "Enhancing Student Creativity and Respect for the Linkages Between Analysis and Design in a First Year Engineering Course" American Society for Engineering Education, Annual Proceedings, Session 3253.

[3] Rube Goldberg Inc. (2003), The Official Rube Goldberg Web Site, Online: http://www.rube-goldberg.com/default.htm, viewed January 10,2004.

[4] Cashman, E. C. and E. A. Eschenbach (2004), *Designing a New Learning Environment for Introductory Environmental Engineering and Science Students: NSF Sponsored CCLI Grant No.DUE-0127139* Online: http://www.humboldt.edu/~eae1/CCLI02/, viewed January 6, 2004.

[5] Eschenbach, E. A. (1998) Web Based Forms for Design Team Peer Evaluations. Proceedings of the Annual Conference of the American Society for Engineering Education.

[6] Eschenbach, E. A. (1997) Peer Evaluation for Design Team Effectiveness. Proceedings of the Annual Conference of the American Society for Engineering Education.

[7] Wilson, J. (1994). The CUPLE physics studio. The Physics Teacher. 32(9):518-523. December.

[8] Williams, P. J. , MacLatchy, S. Cyrus, P, J. Backman, and D. S. Retson (1996) Studio Physics Report on the Acadia Advantage. Acadia University, Wolfville, Canada. ONLINE: http://www.acadiau.ca/advantage/physics.htm.

[9] Environmental Resources Engineering (2003) HSU- ERE Design Studio, Online: http://www.humboldt.edu/~ere_dept/map_sched/sd_link_pages/sd_17_designstudio.html, viewed January 10, 2004.

[10] Project Kaleidoscope (2000) PKAL Summer Institute – Putting the Pieces Together: Leadership Initiatives, Online: http://lists.pkal.org/curricul/keystone/leadership-zoti.html, viewed January 12, 2004.

[11] Oakley, B. (2003) Tomorrow's Professor Msg.#441 Coping With Hitchhikers And Couch Potatoes On Teams, Online: http://ctl.stanford.edu/Tomprof/postings/441.html, viewed January 12, 2004.

[12] Bellamy, L. D. L. Evans, D. E. Linder, B. W. McNeill, and G. Raupp (1994) Teaming Information and Classroom Materials, Online: http://www.eas.asu.edu/~asufc/teaminginfo/teams.html, viewed January 12, 2004.

Biographical Information

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Appendix I – Progress Report Template

The progress reports are just minutes from your meetings. Below is a template that you can cut and paste into your progress reports.

MEETING
- Location:
- Date:
- Time Started:
- Time Finished:
- Team members in attendence (and roles):
- Team members NOT in attendence (or LATE):

NEXT MEETING TIME, DATE AND LOCATION:

OLD BUSINESS
(repeat the next five lines as needed. Suggestion: cut and paste them out of the previous progress report)

OLD ACTION ITEM
- Title:
- Person Responsible:
- Date Due:
- Status: Complete/Incomplete/Late

NEW BUSINESS
(repeat the next five lines as needed.)

NEW ACTION ITEM
- Title:
- Person Responsible:
- Date Due:
- Status: Complete/Incomplete/Late