Learning Outcomes for Teamwork Session

The workshop participant should be able to:

1. Describe why teams are important for student learning.
2. Describe characteristics of a successful teamwork experience.
3. Describe the five tenets of cooperative learning in their own words.
4. Evaluate situations to determine if they satisfy the five tenets of cooperative learning.
5. Realize the need to develop students’ teamwork skills.
6. Identify the problems associated with organizing and managing teams.
7. Realize the importance of providing an instructional framework to nurture teamwork.
8. Evaluate problems for appropriateness of teamwork.
9. Design a problem appropriate for student teamwork in one of their courses.
Five Tenets of Cooperative Learning

Project Catalyst uses the pedagogical framework of “cooperative learning” to practice teamwork and allow students to develop and gain confidence in their team skills.

“Cooperative learning is instruction that involves students working in teams to accomplish an assigned task and produce a final product (e.g., a problem solution, critical analysis, laboratory report, or process or product design), under conditions that include the following elements (Johnson, et al., 1998):

- **Positive interdependence.** Team members are obliged to rely on one another to achieve the goal. If any team members fail to do their part, everyone on the team suffers consequences.

- **Individual accountability.** All team members are held accountable both for doing their share of the work and for understanding everything in the final product (not just the parts for which they were primarily responsible).

- **Face-to-face promotive interaction.** Although some of the group work may be done individually, some must be done interactively, with team members providing mutual feedback and guidance, challenging one another, and working toward consensus.

- **Appropriate use of teamwork skills.** Students are encouraged and helped to develop and exercise leadership, communication, conflict management, and decision-making skills.

- **Regular self-assessment of team functioning.** Team members set goals, periodically assess how well they are working together, and identify changes they will make to function effectively in the future.†

Reading the above five tenets, one can see that teamwork is an integral part of cooperative learning. Cooperative learning has many benefits beyond being a training ground for teamwork.

“An extensive body of [educational] research confirms the effectiveness of cooperative learning in higher education. Relative to students taught conventionally, cooperatively-taught students tend to exhibit better grades on common tests, greater persistence through graduation, better analytical, creative, and critical thinking skills, deeper understanding of learned material, greater intrinsic motivation to learn and achieve, better relationships with peers, more positive attitudes toward subject areas, lower levels of anxiety and stress, and higher self esteem (Johnson, et al., 1998; McKeachie, 1999).”†

In Project Catalyst, a team is two or more persons who work together to achieve a common purpose and practice the five tenets of cooperative learning. However, we do not want to imply that group work is inferior to teamwork. Group work such as having students turn to their neighbor in class to solve a problem can be valuable learning experiences. For effective learning, the educator needs to provide a variety of learning activities, e.g., lecture, group work, and teamwork.

Teaching Scenarios for Analysis Using the Five Tenets of Cooperative Learning

**Circle Scenario:** Instructor assigns a team of four students a topic to research and write a 10-page paper. At the team meeting, three of the students say they are very busy and can’t spend much time on the assignment. One student does most of the research and writes the paper. The team hands in the paper and the instructor gives all four team members a grade of A.

**Square Scenario:** The instructor assigns eight exercises from the back of the chapter. The four-team members decide that each will do two problems. They meet only to staple the pages together before they hand in the assignment.

**Star Scenario:** A four-member team is assigned a one-week project that contains four problems to solve. During the week, each lecture period is devoted to covering the concepts needed to solve the problems. Also, the instructor illustrates the material by solving example problems. The team is asked to work collaboratively on the assignment and to provide a team solution at the end of the week. On the next exam, one problem will be on the material and students must solve it by themselves.

**Triangle Scenario:** In a senior design course, the instructor allows the students to form their own teams of four and on the first day reveals the problem to be solved. The teams are enthusiastic and work hard the first few weeks but soon several teams are dysfunctional.
Tuesday Night:  7:00 –9:30 p.m. Movie
Dana 120C

The Flight of the Phoenix
A Tension-Packed Survival Drama

When a cargo plane crashes in the desert, the only hope for the survivors is to try to rebuild the craft before they all perish from heat, deprivation and hostile nomads. A veteran bomber pilot off-screen, James Stewart is perfectly cast as the Captain, and Richard Attenborough is superb as the navigator. Also starring Peter Finch and Ernest Borgnine, this film combines finely-honed character studies with a plot charged with suspense. Their survival is strongly linked to their abilities to communicate, exercise leadership, resolve conflicts, and make decisions. We encourage you to see the movie.
Learning Outcome Elements for the Ability to Function on Teams

Collaboration/Conflict Management
- Team Development: Basic principles of group development and interpersonal dynamics.
- Interpersonal Style: Recognizing and capitalizing on differences in style and perspective.
- Conflict Management: Principles of problem-based conflict management.
- Participation: Understanding of and willingness to be fully involved in team efforts.

Team Communication
- Active Listening: Conveying understanding and using listening skills to move a conversation forward.
- Feedback: Giving and receiving constructive criticism.
- Influencing others: Persuading others through well-reasoned use of facts and clear conveyance of ideas.
- Sharing Information: Providing and reviewing information in a timely manner.

Team Decision-making
- Defining a Problem: Identifying and articulating the problem to be solved.
- Innovation/Idea generation: Generating creative and viable solutions.
- Judgment/Using facts: Reaching conclusions based upon clear analysis of facts and ideas.
- Reaching Consensus: Ensuring buy-in and commitment to decisions reached.

Self-Management
- Establishing directions and standards: Helping create plans and structure for the team.
- Managing meetings: Using principles of effective team meetings
- Personal conduct: Demonstrating personal responsibility to the team and respect for team members.
- Leadership: Being proactive and moving the team closer to its goal.


‡ Added by the Project Catalyst Team, College of Engineering, Bucknell University, Lewisburg, PA, July 2003.
Team Formation Checklist

- Explain to the students what you are doing and why.
- Instructor should form teams with goal to spread ability, skills and learning styles.
- Instructor should assign team roles and have members rotate.
- Team size should be 3 or 4 students.
  - Less than 3, not enough variety in ideas.
  - More than 4, one or more are left out.
- Duration should be at least several weeks.
  - A team is more likely to function better the longer they are together. Takes time to form a functioning team.

Team Management Checklist

- Team contract
  - Guide team to create own contract. Ownership by the team helps buy-in by the members.
  - Have the team develop procedures for poor behavior, e.g., Can a team member be fired?
  - Have team develop a self-assessment instrument.
- Require a structure for team meetings.
- Have the team keep a notebook.
- Develop teamwork skills through student learning activities to:
  - Understand the learning styles of all team members,
  - Understand the dynamics of teamwork,
  - Develop a project team contract,
  - Practice leadership in the team by all members,
  - Develop effective interpersonal skills for communication, conflict management, and team decision making,
  - Conduct self-assessment of the team’s performance, and
  - Improve continuously the team’s performance.

More details in our “Practical Guide to Teamwork” on CD-ROM.
Leadership Demonstration

Traffic Jam Rules

Instruction: $\rightarrow \rightarrow$ represents Person 1 facing in the indicated direction.

Each team member is to take a starting position as shown:

$\rightarrow \rightarrow$ $\rightarrow$ $\rightarrow$ $\rightarrow$ $\rightarrow$

The object is for all persons on the left to end up on the right and vice versa using only the legal moves described below.

Legal Moves:
1. A person may move into an empty space in front of him or her.
2. A person may move around a person who is facing her or him into an empty space.

Illegal Moves:
1. Any move backwards.
2. Any move around someone facing the same direction you are.
3. Any move which involves two or more persons moving at the same time.
# An Instructional Framework to Nurture Teamwork

To foster good behaviors and minimize poor behaviors, have students:

| nurture understanding | • recognize different learning styles of team members (Guide, Ch. 3).  
|                       | • appreciate the stages of team development (Guide, Ch. 2).  
|                       | • participate in the development of a team contract (Guide, Ch. 2).  
| nurture communication | • keep a team notebook and possibly a personal technical journal (Guide, Ch. 2).  
|                       | • write weekly memo reports on team’s progress for the problem (Guide, Ch. 5).  
|                       | • set milestones, monitor team’s progress, and make adjustments (Guide, Ch. 5).  
|                       | • conduct regular team meetings with and without the instructor (Guide, Ch. 5).  
|                       | • participate in assigned roles and rotate through those roles (Guide, Ch. 2).  
| nurture improvement   | • practice problem solving and decision making (Guide, Ch. 6).  
|                       | • conduct self-assessments on team’s performance (Guide, Ch. 6).  
|                       | • process those assessments and implement corrective actions (Guide, Ch. 6).  
|                       | • use the team contract to discourage detrimental behavior (Guide, Ch. 2).  
|                       | • use available resources to resolve disagreements (Jogger, Ch. 5).  

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**References**

Bucknell’s Catalyst Team on Teamwork (Jeff Csernica, Mike Hanyak, Dan Hyde, Steve Shooter, Mike Toole and Margot Vigeant), *Practical Guide to Teamwork*, Version 1.1, Bucknell University, Lewisburg, PA, June 26, 2002.


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**Practical Advice:**

- explain to the students what you are doing and why.
- account for students’ earlier experiences with teamwork.
- design activities to incorporate the five tenets of cooperative learning.
- provide more structure and less control by students in first experiences.
- migrate to less structure and more control by students in later experiences.
- encourage continuous improvement activities, their key to successful teamwork.
- provide resources to help students develop their teamwork skills.
- design appropriate problems that need teamwork to find their solutions.
Sophomore students in chemical engineering must learn to apply the principle of material balances to solve well-defined problems. They must distinguish between different types of systems—continuous with no chemical reaction, batch, semi-batch, and continuous with chemical reaction. Starting with the fundamental conservation law of matter, students can write material balances based on mass, moles, or atoms. They are asked to explicitly practice the following six steps of a problem solving methodology to solve well-defined problems:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. understand the problem</td>
<td>conceptual model or a diagram</td>
</tr>
<tr>
<td>2. define the problem</td>
<td>mathematical model</td>
</tr>
<tr>
<td>3. devise a plan</td>
<td>mathematical algorithm</td>
</tr>
<tr>
<td>4. carry out the plan</td>
<td>numerical solution</td>
</tr>
<tr>
<td>5. review the problem</td>
<td>heuristic observations</td>
</tr>
<tr>
<td>6. report the problem</td>
<td>formal documentation</td>
</tr>
</tbody>
</table>

This methodology provides a step-by-step structure that helps students to reach the final goal, a single correct answer. Although these steps or stages are sequential, feedback exists between stages. For example, while reviewing the problem solution, a student might observe the need to calculate another quantity, which was forgotten in the original mathematical model.

A four-member team is assigned a two-week project that contains four problems (P1, P2, P3, P4) to solve the material balances for four different systems. During the two weeks, each two-hour lecture period is devoted to each step in the problem-solving methodology, as illustrated in the following diagram:

At each lecture period, all students in a team are focusing on the same step in the problem-solving methodology, but each is doing it on a different problem. Before a lecture period, a team member must develop a draft outside of class and bring it to the lecture period. These drafts are used to focus the discussions and then plan for the next period. When team members move to the next lecture period, they will all have the same focus but on a different problem. At the end of the two weeks, all team members will have worked on all four problems and interacted with each other. In the sixth period, teams are required to spend time doing self-assessment of their team functioning. On the next exam, one problem will be on material balancing, and students must solve it by themselves.
You are employed as a systems analyst at Bison Scientific, a company that develops software tools for the Internet. Your team of three or four has been asked to research, design and build a prototype of a computer-based collaborative system called a shared whiteboard. The goal is to allow users to collaborate to solve problems over long distances using their PCs or workstations connected to the Internet. For portability across Windows and Unix platforms, your team is to use the Java programming language.

The class will study and use modern software engineering techniques including eXtreme Programming (XP), a light-weight methodology which requires pair programming, unit testing, weekly interaction with a customer as well as other aspects. Each team will be assigned an outside customer who will specify through XP stories of the details of the actual system to be designed.

Milestones in the form of XP iterations (every week) and releases (every month) are due during the semester. In XP, an “Iteration” is a short period of time (in this case a week) where the team designs, implements and tests a part of the product as specified by the stories selected by the customer. The customer tries out the system and provides feedback. Also, the customer selects the next set of stories (or part of a story) for the next Iteration. A “Release” is a major milestone. A Release might mean that a suitable but not quite complete product is given to real customers to try out. In our case, a Release means a working product, associated documents (e.g., user manual, javadoc web pages, report) and 10-minute class presentation.

At the end of the semester, each team presents a formal 20-minute talk and writes a paper which includes a technical manual for the software and where they reflect on the process of using XP and working on Teams. Each team will be required to maintain a Project Notebook that will be periodically graded by the instructor. Each team will create a team contract of expected team behavior. From their team contract, each team will create an evaluation form. This form will be used to assess each individual’s participation several times during the semester and will be worth 10% of the student’s grade.

Each team member must act in an ethical, legal and professional manner.
ELEC 480 is a required senior course in control systems for electrical engineering students with a high design content. Prior to the start of the semester, the instructor assigned students to lab groups, and to homework groups. In every case, each group had one high GPA student and one low GPA student. That left a group of middle level GPA students who were assigned to form lab groups and homework groups of either three or four students. In the lab groups, students were given a set of roles. Those roles were:

- **Coordinator** – Responsible for calling meetings, etc. and presenting the report,
- **Technical Resources** – Responsible for Instrumentation and Systems,
- **Technical/Data Analyst** – Responsible for analysis of data,
- **Editor** – Responsible for editing the report.

When there were three students in the group, the Coordinator and Editor positions were collapsed into one position.

The lab consisted of four extended, open-ended laboratory problems of either three- or four-week duration. During that time, students stayed in one role. At the end of each laboratory problem, roles were rotated, and each student assumed the role of Coordinator, Technical Resource and Data Analyst at least once. Students also rotated through several different systems to be controlled, and they needed to share measurement results from one course segment in later course segments.

For each laboratory problem, students were requested to fill in a peer evaluation form (based on a form by Felder) at end of the segment.

This course also made use of Blackboard, a web-based course management system (see web link [http://www.blackboard.com](http://www.blackboard.com)). Students were able to post their completed laboratory reports using BlackBoard, and that is the way measurement results were shared among the students.

Blackboard also gave a good opportunity to provide students with interesting links related to various aspects of the course. Some link sets were Team Related Issues, PID Controllers, Linear Systems Review, Ethics, etc. For the set of Team Related Issues, a quick search of the net provided numerous stories about teaming, definitions of the Tuckman model, and a quiz that teams could take to determine their progress through the Tuckman model. All of those links were provided to the students at the beginning of the course.
This class in environmental engineering will be divided into groups of 3-4 students. Each group will be required to write a position paper on an assigned topic (listed below). In addition to the paper, the groups will participate in a debate near the end of the semester, which will be graded and critiqued by non-participating students. The purpose of this project is to have students critically evaluate the data on both sides of a global issue and support a conclusion.

**Issue 1. Global Warming**

Position 1. Global warming is a result of increased CO$_2$ levels due to human activity and therefore we, as humans, should take measures to curb the release of CO$_2$ in the atmosphere. **Outcome:** You will convince the audience that the United States should sign the Kyoto Protocol.

Position 2. Global warming may not be in fact occurring, and if it is, it cannot definitively be linked to CO$_2$ production, and therefore, due to these and other uncertainties, we should not take steps that will reduce CO$_2$ emissions since they will cause significant economic hardship on industries and peoples lives. **Outcome:** You will convince the audience that the United States should **not** sign the Kyoto Protocol.

**Issue 2. Ozone Depletion**

Position 1. Ozone depletion is a result of the release of chlorofluorocarbons (CFCs) from human activity and ozone depletion will result in increased health problems for humans and other species, therefore, we should act to reduce the emission of ozone depleting materials.

Position 2. Ozone depletion is not really occurring, and if it was due to CFCs, the human output is not really significant compared to natural sources. In addition, the cause and effect of ozone depletion and health problems is weak. For these reasons and others, costly controls of CFCs should not be enacted.

**Issue 3. Acid Rain**

Position 1. Acid rain is the result of compounds released from power plants and it causes widespread damage to natural ecosystems, therefore, strict regulations should be enacted to minimize the release of acid rain causing compounds.

Position 2. Acid rain is not a significant problem, and because of this and other reasons, regulations and strict controls are unwarranted due to their high costs.

**Issue 4. Dredging the Hudson River by GE**
How to Engineer Engineering Education
A Catalyst for Change, Teamwork Session

Position 1. The EPA should force GE to dredge the Hudson River in order to remove pollutants that have collected and persisted in the sediments of the Hudson River. This is necessary for the long-term health of the river.

Position 2. The EPA should not force GE to dredge the Hudson River and should allow the sediments to remain undisturbed.

Issue 5. Drilling in the Arctic Refuge for Oil

Position 1. The US Government should allow oil drilling and production in the Arctic Refuge.

Position 2. The US Government should not open the Arctic Refuge to oil drilling.

Debate Forum. Each group will be given 10 minutes to present their paper beginning with Position 1. After each presentation with no discussion from the other team or audience, each Position will be given 5 minutes of rebuttal. After the rebuttal, the debate will become an open forum with questions from the audience and moderator. The presentations, rebuttals, and open forum discussion will be graded by the instructor and classmates. A total of 52 minutes will be allowed for each debate topic during the class period.

Project Report. On December 5th, all project reports will be due. The reports will be a written document that outlines your group's position and the data/information that supports your position. There is no length requirement or limit for this document. Each paper must have been reviewed at least once by the writing center.

Project Grading. The project report will account for 50% of the project grade, and the presentation will account for 50% of the project grade. Each member will be graded individually on their presentation.

Important Project Due Dates:

September 17th – 1 page outline of the project report and 1st team review due.

October 1st – 1 page outline of project debate form and 2nd team review due.

October 31st – Draft of project report with writing center comments due – 3rd team review.

December 5th – Final report due and presentations during this week – 4th team review.

Team Reviews

Based on development of the important teamwork attributes that will be developed as a class, a review system will be developed to assess each team member and the team as a whole. The objective of this review is to provide feedback to each team and team member and also to provide an opportunity to improve team dynamics and effectiveness. The reviews will be incorporated into the grades for the project as proposed by the class.
Teamwork References


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Phillips, P. "So, You're Going to be a Member of a Team." Chemical Engineering Progress, January 1997, pp. 141-144.