Design and Implementation of Interactive Learning – Part 2

Karl A. Smith
Engineering Education – Purdue University &
Civil, Environmental, and Geo- Engineering – University of Minnesota
ksmith@umn.edu
https://karlsmithmn.org/

Megan Reder-Schopp
Director of Counseling
South Dakota School of Mines and Technology
Megan.Reder-Schopp@sdsmt.edu

Session Layout

Welcome & Overview
BIG IDEAS (Enduring Outcomes)
- How Learning Works
- Streamlined Course Design
- Alignment of Outcomes, Assessment and Instruction
- Interactive Learning

Interactive (Cooperative) Learning
- Description & Rationale
  - Key Concepts
  - Types of Cooperative Learning
- Project-Based Learning activity
- Formal Cooperative Learning planning exercise

Implementing Interactive Learning
- Practice
- Examples
- Applications
Big Ideas (Enduring Outcomes)

- How Learning Works
- Streamlined Course Design
- Alignment of Outcomes, Assessment and Instruction
- Interactive Learning

Overall Goals

- Build your knowledge of Cooperative Learning and your implementation repertoire
- Implement practices to improve student learning
Cooperative Learning Objectives

Participants will be able to list and describe essential features of the instructor’s role in implementing cooperative learning.

Participants will be able to elaborate on multiple ways Positive Interdependence and Individual Accountability can be structured.

Participants will identify features to implement in their own courses.

PROJECT-BASED LEARNING VIGNETTE

Jon J Kellar - Materials and Metallurgical Engineering

- Course: Met 220L Mineral Processing and Resource Recovery
- Required laboratory course for Metallurgical Engineering students
- Enrollment typically 20-25 students, taught every spring semester
- Prior to 2015 taught in a traditional manner, weekly lab exercises and student memo/lab report
- There were 15 lab exercises, often leaving unused time within the 3 hour laboratory time block (opportunity for efficiency)
PROJECT-BASED LEARNING VIGNETTE

- Concept---make labs more efficient and merge like labs to create a five-week final project
- The project would require that students ‘put into practice’ the prior lab training (magnetic, gravity separation etc.)
- Projects typically are of local interest---first project was the ‘Gold Rush’ project (see image)

![Image of National Smelting Company with text: National Smelting Company had smelter on edge of campus—adjacent present day O’Harra Stadium]

PROJECT-BASED LEARNING VIGNETTE

- Gold Rush Project involves student teams collecting samples from ‘Smelter Hill’ and determining how much gold they could concentrate
- Five out of six teams were able to assay for gold content with the winning team producing a sample assaying at 63 oz/ton
- Subsequent projects have involved concentration of nickel powder from spent 3D printing powder, concentration of garnet from spent water jet cutting materials and a ‘student selection’ project
PROJECT-BASED LEARNING VIGNETTE

- Assessment results (student course surveys and SGID) indicate that the students enjoy the final project, and also appreciate the competitive aspects and team-building associated with the project.

- Instructor assessment---much more rewarding teaching experience than previous format, allows industrial interaction that feeds into departmental senior design projects, student hires, research and fundraising.

- Questions/Comments? jon.kellar@sdsmt.edu

Structuring Teamwork in the Classroom

Formal Cooperative Learning Task Groups
Reflection and Dialogue

Individually reflect on the Characteristics of High Performing Teams. Think/Write for about 1 minute

- Base on your experience on high performing teams,
- Or your facilitation of high performing teams in your classes,
- Or your imagination

Discuss with your team for about 2 minutes and record a list
Characteristics of High Performing Teams

A team is a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable:

- SMALL NUMBER
- COMPLEMENTARY SKILLS
- COMMON PURPOSE & PERFORMANCE GOALS
- COMMON APPROACH
- MUTUAL ACCOUNTABILITY

--Katzenbach & Smith (1993)

*The Wisdom of Teams*
Cooperative Learning is instruction that involves people working in teams to accomplish a common goal, under conditions that involve both positive interdependence (all members must cooperate to complete the task) and individual and group accountability (each member is accountable for the complete final outcome).

Key Concepts

- Positive Interdependence
- Individual and Group Accountability
- Face-to-Face Promotive Interaction
- Teamwork Skills
- Group Processing

Six Basic Principles of Team Discipline

- Keep membership small
- Ensure that members have complimentary skills
- Develop a common purpose
- Set common goals
- Establish a commonly agreed upon working approach
- Integrate mutual and individual accountability

Katzenbach & Smith (2001) The Discipline of Teams

Hackman – Leading Teams

Real Team
Compelling Direction
Enabling Structure
Supportive Organizational Context
Available Expert Coaching

Team Diagnostic Survey (TDS)
https://research.wjh.harvard.edu/TDS/

Real Team

clear boundaries
team members are interdependent for some common purpose, producing a potentially assessable outcome for which members bear collective responsibility
at least moderate stability of membership
Compelling Direction

Good team direction is:
- challenging (which energizes members)
- clear (which orients them to their main purposes)
- consequential (which engages the full range of their talents)

Enabling Structure

Key structural features in fostering competent teamwork
- **Task design**: The team task should be well aligned with the team’s purpose and have a high standing on “motivating potential.”
- **Team composition**: The team size should be as small as possible given the work to be accomplished, should include members with ample task and interpersonal skills, and should consist of a good diversity of membership
- **Core norms of conduct**: Team should have established early in its life clear and explicit specification of the basic norms of conduct for member behavior.
The five keys to a successful Google team

Pod. Work group. Committee. Autonomous collective. Whatever you call it, you’re part of one at Google and probably wherever you work: a team. So if we know what makes managers great, why don’t we know what makes a team great?

Update check out the re:work guide: Understand team effectiveness for the full play on Google team effectiveness research as well as tools to help teams find psychological safety.

A group of us at Google, People Operations (what we call HR) set out to answer this question using data and rigorous analysis: What makes a Google team effective? We shared our research earlier today with the Associated Press, and were sharing the findings here, as well.

Over two years we conducted 250+ interviews with Googlers (our employees) and looked at more than 130 attributes of 160+ active Google teams. We were pretty confident that we’d find the perfect mix of individual traits and skills necessary for a stellar team - like one Rhodes Scholar, two entrepreneurs, one engineer who works at Angara, 2, and a PO. Voila. Dream team assembled, right!

We were dead wrong. Who is a team matters less than how the team members interact, structure their work, and view their contributions. So much for that magical algorithm.

We learned that there are five key dynamics that set successful teams apart from other teams at Google:

1. Psychological safety: Can we take risks on this team without feeling insecure or embarrassed?
2. Dependability: Can we count on each other to do high-quality work on time?
3. Structure & clarity: Are goals, roles, and execution plans on our team clear?
4. Meaning of work: Are we working on something that is personally important for each of us?
5. Impact of work: Do we fundamentally believe that the work we do matters?

The five keys:

1. Psychological Safety
   Team members feel safe to take risks and be vulnerable in front of each other.

2. Dependability
   Team members get things done on time and meet Google’s high bar for excellence.

3. Structure & Clarity
   Team members have clear roles, plans, and goals.

4. Meaning
   Work is personally important to team members.

5. Impact
   Team members think their work matters and creates change.

https://rework.withgoogle.com/blog/five-keys-to-a-successful-google-team/

---

Does Psychological Safety Hinder Performance?

Psychological safety does not operate at the expense of employee accountability; the most effective organizations achieve high levels of both, as this matrix shows.

Creative Performance Requires Maintaining a Creative Tension Between Challenge and Security


<table>
<thead>
<tr>
<th>Psychological Safety</th>
<th>Accountability for Meeting Demanding Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HIGH</strong></td>
<td><strong>Comfort zone</strong></td>
</tr>
<tr>
<td></td>
<td>Employees really enjoy working with one another but don’t feel particularly challenged. Nor do they work very hard. Some family businesses and small consultancies fall into this quadrant.</td>
</tr>
<tr>
<td></td>
<td><strong>Learning zone</strong></td>
</tr>
<tr>
<td></td>
<td>Here the focus is on collaboration and learning in the service of high-performance outcomes. The hospitals described in this article fall into this quadrant.</td>
</tr>
<tr>
<td><strong>LOW</strong></td>
<td><strong>Apathy zone</strong></td>
</tr>
<tr>
<td></td>
<td>Employees tend to be apathetic and spend their time jockeying for position. Typical organizations in this quadrant are large, top-heavy bureaucracies, where people fulfill their functions but the preferred modus operandi is to curry favor rather than to share ideas.</td>
</tr>
<tr>
<td></td>
<td><strong>Anxiety zone</strong></td>
</tr>
<tr>
<td></td>
<td>Such firms are breeding grounds for anxiety. People fear to offer tentative ideas, try new things, or ask colleagues for help, even though they know great work requires all three. Some investment banks and high-powered consultancies fall into this quadrant.</td>
</tr>
</tbody>
</table>
Cooperation in the College Classroom

- **Informal** Cooperative Learning Groups
- **Formal** Cooperative Learning Groups
- Cooperative Base Groups

Notes: Cooperative Learning Handout
Instructor’s Role in Formal Cooperative Learning

1. Specifying **Objectives** (Academic and Interpersonal/Teamwork)

2. Making **Decisions**

3. Explaining **Task, Positive Interdependence**, and **Individual Accountability**

4. **Monitoring** and Intervening to Teach Skills

5. **Evaluating** Students' Achievement and Group Effectiveness

---

**Formal Cooperative Learning – Types of Tasks**

1. Jigsaw – Learning new conceptual/procedural material

2. Peer Composition or Editing

3. Reading Comprehension/Interpretation

4. **Problem Solving, Project, or Presentation**

5. Review/Correct Homework

6. Constructive Academic Controversy

7. Group Tests
Cooperative Problem/Project-Based Learning

**TASK:** Solve the problem(s) or Complete the project.

**EVALUATION:** Best answer within available resources or constraints.

**INDIVIDUAL:** Develop ideas, Initial Model, Estimate, etc. Note strategy.

**INDIVIDUAL ACCOUNTABILITY:** One member from your group may be randomly chosen to explain (a) the answer and (b) how to solve each problem.

**COOPERATIVE:** One set of answers from the group, strive for agreement, make sure everyone is able to explain the strategies used to solve each problem.

**EXPECTED BEHAVIORS:** Active participating, checking, encouraging, and elaborating by all members.

**EXPECTED CRITERIA FOR SUCCESS:** Everyone must be able to explain the model and strategies used to solve each problem.

**INTERGROUP COOPERATION:** Whenever it is helpful, check procedures, answers, and strategies with another group.

---

**Engineering**

A scientist discovers that which exists. An engineer creates that which never was -- Theodore von Kármán (1881-1963)

The engineering method is design under constraints
– Wm. Wulf, Past President, National Academy of Engineering
Skills often associated with good designers – the ability to:

tolerate ambiguity that shows up in viewing design as inquiry or as an iterative loop of divergent-convergent thinking;

maintain sight of the big picture by including systems thinking and systems design;

handle uncertainty;

make decisions;

think as part of a team in a social process; and

think and communicate in the several languages of design.


Design-Build Project

Teams of 3-4 – randomly assigned

Experience entire project life cycle in about 30 minutes

Goal is for all teams to meet the specification (design requirement)

Attend to both the task and the team work
# Team Member Roles

Observer/Process Recorder (non participant role)  
Facilitator/Time Keeper  
Task Recorder  
Skeptic/Prober

<table>
<thead>
<tr>
<th>Action</th>
<th>Name 1</th>
<th>Name 2</th>
<th>Name 3</th>
<th>Name 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contributes Ideas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Describes Feelings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Encourages Participation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summarizes, Integrates</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Checks for Understanding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relates New To Old Learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gives Direction To Work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Design objective**
Design and build a tower at least 25 cm high that can support a concentrated load (stack of textbooks). The tower is built from index cards and office tape.

**Design rules**
Materials are 100 index cards and one roll of office tape
Cards can be folded but not torn
No piece of tape can be longer than 2 inches
Tower cannot be taped to the floor
Tower must be in one piece, and easily transported in one hand
Time to design and build: 15 minutes
Height is measured from the ground to the lowest corner of the book placed on top
Tower must support books for at least 10 seconds before the measurement is made
Room must be cleaned up before measurements are made.

**Teamwork objective**
Collect and discuss observation data to process team dynamics

---

**Group Processing**
**Plus/Delta Format**

<table>
<thead>
<tr>
<th>Plus (+)</th>
<th>Delta (Δ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Things That Group Did Well</td>
<td>Things Group Could Improve</td>
</tr>
</tbody>
</table>
Teamwork & Project Management Heuristics--Examples

• Identify the weak link and Allocate resources to the weak link
• Freeze the design--at some stage in the project (when about 75% of the time or resources are used up) the design must be frozen
• Discuss the process and ask meta-level questions, e.g., What are we doing? Why are we doing it? How does it help?

Problem-Based Learning
Problem posed
Learn it
Identify what we need to know
Apply it

Subject-Based Learning

START

Given problem to illustrate how to use it
Learn it

Told what we need to know

Normative Professional Curriculum:
1. Teach the relevant basic science,
2. Teach the relevant applied science, and
3. Allow for a practicum to connect the science to actual practice.
Problem-Based Learning (PBL)

Problem-based learning is the learning that results from the process of working toward the understanding or resolution of a problem. The problem is encountered first in the learning process – Barrows and Tamlyn, 1980

Core Features of PBL

- Learning is student-centered
- Learning occurs in small student groups
- Teachers are facilitators or guides
- Problems are the organizing focus and stimulus for learning
- Problems are the vehicle for the development of clinical problem-solving skills
- New information is acquired through self-directed learning

Cooperative Learning is instruction that involves people working in teams to accomplish a common goal, under conditions that involve both positive interdependence (all members must cooperate to complete the task) and individual and group accountability (each member is accountable for the complete final outcome).

Key Concepts

- Positive Interdependence
- Individual and Group Accountability
- Face-to-Face Promotive Interaction
- Teamwork Skills
- Group Processing

Instructor’s Role in Formal Cooperative Learning

1. Specifying Objectives (Academic and Social/Teamwork)

2. Making Decisions

3. Explaining Task, Positive Interdependence, and Individual Accountability

4. Monitoring and Intervening to Teach Skills

5. Evaluating Students' Achievement and Group Effectiveness

Decisions, Decisions...

- Group size?
- Group selection?
- Group member roles?
- How long to leave groups together?
- Arranging the room?
- Providing materials?
- Time allocation?
Optimal Group Size?

A. 2
B. 3
C. 4
D. 5
E. 6

Formal Cooperative Learning Task Groups

Group Selection?

A. Self selection  
B. Random selection  
C. Stratified random  
D. Instructor assign  
E. Other

Assigning Roles

Chapter 8: Group Roles and Responsibilities  
- Roles  
  - Facilitator  
  - Checker  
  - Set-Up  
  - Materials Manager  
  - Safety Officer  
  - Reporter  
  - Dividing the labor
Teamwork Skills

- Communication
  - Listening and Persuading
- Decision Making
- Conflict Management
- Leadership
- Trust and Loyalty

Chapters 3, 4, 5 & 6

TEAMWORK

Teaching Cooperative Skills

1. Help students see the need to learn the skill.
2. Help them know how to do it (T-chart).
3. Encourage them to practice the skill daily.
4. Help them reflect on, process, & refine use.
5. Help them persevere until skill is automatic

Monitoring, Observing, Intervening, and Processing

Monitor to promote academic & cooperative success

Observe for appropriate teamwork skills: praise their use and remind students to use them if necessary

Intervene if necessary to help groups solve academic or teamwork problems

Process so students continuously analyze how well they learned and cooperated in order to continue successful strategies and improve when needed
Team Charter

- Team name, membership, and roles
- Team mission
- Anticipated results (goal)
- Specific tactical objectives
- **Ground rules/ Guiding principles for team participation**
- Shared expectations/aspirations

PPP. 60-61, 204-205

---

**Group Ground Rules Contract Form**

(Adapted from a form developed by Dr. Deborah Allen, University of Delaware)

Project groups are an effective aid to learning, but to work best they require that all group members clearly understand their responsibilities to one another. These project group ground rules describe the general responsibilities of every member to the group. You can adopt additional ground rules if your group believes they are needed. Your signature on this contract form signifies your commitment to adhere to these rules and expectations.

All group members agree to:

1. Come to class and team meetings on time.
2. Come to class and team meetings with assignments and other necessary preparations done.

Additional ground rules:

1. 
2. 

If a member of the project team repeatedly fails to meet these ground rules, other members of the group are expected to take the following actions:

Step 1: (fill in this step with your group)

If not resolved:

Step 2: Bring the issue to the attention of the teaching team.

If not resolved:

Step 3: Meet as a group with the teaching team.

The teaching team reserves the right to make the final decisions to resolve difficulties that arise within the groups. Before this becomes necessary, the team should try to find a fair and equitable solution to the problem.

Member’s Signatures: Group Number:

1. __________________ 3. __________________
2. __________________ 4. __________________
Designing and Implementing Cooperative Learning

Think like a designer
Ground practice in robust theoretical framework
Start small, start early and iterate
Celebrate the successes; problem-solve the failures

Formal Cooperative Learning Planning

1. Develop a Formal Cooperative Learning Plan – see Handout ~ 5 minutes
   1. Topic
   2. Academic and Teamwork objectives
   3. Task
   4. Positive Interdependence and Individual Accountability

2. Share and discuss plan with your group ~10 min
The Instructor's Role in Cooperative Learning

Make Pre-Instructional Decisions

Specific Academic and Task Objectives: The teacher has both W objective and 1) specific goals and group goals. These goals will be used to evaluate the effectiveness of the group's performance.

Decide on Group Size: Group size should be large enough to promote cooperation but small enough to allow for effective communication.

Decide on Group Composition: Assign students to groups based on ability levels, interests, and goals.

Assign Roles: Each group member should have a specific role, such as Facilitator, Recorder, Encourager, or Recorder for Collaboration.

Assign Tasks: Assign tasks to groups based on the abilities and goals of the group.

Explain the Task: Explain the task, the criteria for success, and the expected outcomes.

Explain the Cooperative Task: Explain the task, the criteria for success, and the expected outcomes.

Explain the Cooperative Group: Explain the norms, the criteria for success, and the expected outcomes.

Develop Cooperative Strategies: Develop strategies to help the group achieve success.

Evaluate and Process

Evaluate Student Learning: Evaluate the effectiveness of the cooperative learning activity.

Review Group Process: Review the group's process and outcomes.

Review Group Outcomes: Review the group's outcomes and the effectiveness of the cooperative learning activity.

Evaluate and Process

Cooperative Lesson Planning Form

Objective

Date

Objectives

Assessment

Social Skills

Pre-Instructional Decisions

Group Size: ________ Method of Assigning Students: ________

Roles

Groups: ________ Task Assignment: ________

Materials

1. One Copy Per Group

2. Paper

3. Other

Explain Task and Cooperative Goal Structure

1. Task

2. Vocab 2 Peer Review

3. Positive Interdependence

4. Interpersonal Accountability

5. Group Cooperation

6. Debriefing

Monitoring and Intervening

1. Observation Procedure: ________ Format: ________ Content: ________

2. Observation By: ________ Teacher: ________ Student: ________

3. Intervention For Task Assistance: ________

4. Intervention For Task Assistance: ________

5. Other:

Evaluating and Processing

1. Assessment Of Individual Learning: ________

2. Assessment Of Group Productivity: ________

3. Small Group Processing: ________

4. Whole Class Processing: ________

5. Checkpoint: ________

6. Positive Feedback To Each Student: ________

7. Goal Setting For Improvement: ________

8. Criteria: ________

9. Other:
Follow up sessions – Suggested Format

1. Share successes. Volunteers share something they tried that is working.
2. Learn something new.
3. Problem solve challenges and barriers

Identify, Formulate, and Solve Problems

Expect Some Problems, Challenges, and Barriers

1. Recognize problems when they appear (or before they appear)
2. With one or more colleagues, develop three or more solutions
3. Implement one, evaluate, replan, and retry
SCALE-UP
Student-Centered Active Learning Environment with Upside-down Pedagogies

How would you like to teach (or learn) in a classroom like this one at NCSU?

The purpose of this website is to share designs for state-of-the-art learning studios, teaching methods, and instructional materials that are based on more than a decade of discipline-based education research.

For a quick introduction, visit our Frequently Asked Questions page, or view a some of these short video clips created by adopters.

Minnesota, McGill, Iowa, Virginia Tech, UI-Davenport, Northern Michigan, Oklahoma, Woodward High School

As a visitor to the site, you can view classroom designs and find contact information for scores of colleges and a growing number of high schools that are offering highly interactive, collaborative, guided-inquiry-based instruction.

Registered site members have access to many more details and classroom materials being developed and tested by faculty from around the world.

Visitors may click here to go to pages describing the work of many of the institutions adopting SCALE-UP.

Registered site members, click here to log in. (There is additional detailed information available only to those who have registered.)

http://scaleup.ncsu.edu/
Cooperative Problem-Based Learning

At M.I.T., Large Lectures Are Going the Way of the Blackboard


http://web.mit.edu/edtech/casestudies/teal.html#video
http://tile.uiowa.edu/

http://mediamill.cla.umn.edu/mediamill/embed/78755


http://www.youtube.com/watch?v=lfT_hoiuY8w
Inside an Active Learning Classroom

STSS at the University of Minnesota

http://vimeo.com/andyub/activeclassroom

“I love this space! It makes me feel appreciated as a student, and I feel intellectually invigorated when I work and learn in it.”

http://www.udel.edu/inst/