COOPERATIVE LEARNING

Cooperative learning, whether through group work or class discussion, can have several benefits for student learning. Seminal work by Lev Vygotsky (Vygotsky 1962; 1978) and other learner scientists suggests that substantial learning happens when students solve problems beyond their developmental level, especially with the support of their peers and instructors.

Meta-analyses of the cooperative learning literature have revealed positive patterns. For example:

i. Across 168 studies comparing cooperative learning to competitive and individualistic learning in college students, cooperative learning led to a relative increase in student academic performance by approximately one-half of a standard deviation and improvements in both attitude and self-esteem (Johnson et al., 2006; Kuh et al. 2007)
ii. Across 39 studies comparing STEM classrooms that used small-group activities to those that did not, students that participated in group activities had greater academic achievement and increased persistence through STEM courses (Springer et al. 1999).

Below we highlight strategies and provide useful resources for facilitating both group activities and class discussion.

FACILITATING GROUP ACTIVITIES

Strategies for interacting with students while they are carrying out group activities:

- Regularly observe group interactions and progress, either by circulating during group work, collecting in-process documents, or a combination of both. Here is a collection of handouts that instructors can use to promote effective group interactions.
- Emphasize to students how critical thinking, team building, collaborative interaction, and good listening are all important career / life skills.
- Don't be afraid to commiserate; agree that thinking critically and reaching consensus with a diverse group is challenging. Share examples from your own experience!
- If some students appear to be "freeloading", gently chat with them. Example: "Your group seems to think _____ about this issue. How would you summarize what has been discussed so far?" Try to pull them back into focus.

Strategies for forming groups:

- Determine the group conformation that will help meet your goals. In some cases, it may be best to determine group formation rather than having students form groups with their nearest neighbor.
- Try to form groups that are heterogeneous with regard to skills / abilities / background / academic level. Or, having students count off (1, 2, 3, 4, etc.) is an equitable way to assign students to groups fairly quickly to work on a problem or task.
- Typically groups that are 2-6 students are recommended, with groups of 3 demonstrating the best performance in some problem-solving tasks (Johnson & Mighten 2005; Heller & Hollabaugh 1992).

- It may be useful to assign roles to each of the group members (e.g., manager, skeptic, educator, conciliator, recorder, reporter etc.), and to rotate them on a regular basis (Heller & Hollabaugh 1992).
- Comprehensive Assessment of Team Member Effectiveness (CATME) offers an online tool to assist in group formation, which can be useful for large classes.
- Help groups set expectations. As a starting activity, consider having group members identify and discuss their constructive and destructive behaviors with each other, and agree upon what to do when group member demonstrate their destructive behavior. Group contracts can be helpful.

Strategies for assessing group activities:

- Create rubrics that assess both content AND team skills. The American Association for Colleges and Universitites (AACU) has developed a rubric to assess the qualities of a good team member; AACU Teamwork value rubric.
- Provide frequent opportunities for feedback.
- Give both individual AND group assignments. For example, IF-AT quizzes (i.e., two-phase quizzes or exams) test both individuals and groups, and can be used to promote accountability among group members.
- Make use of peer evaluation (Wenzel 2007).
- The University of New South Wales describes a variety of methods for assessing group work.

Additional useful resources and references:

1. **TIDES teaching portal:** https://cns.utexas.edu/teaching-portal/group-work
2. **Faculty innovation center:** https://facultyinnovate.utexas.edu/group-learning
3. **University of Waterloo Centre for Teaching Excellence:** https://uwaterloo.ca/centre-for-teaching-excellence/teaching-resources/teaching-tips/developing-assignments/group-work/group-work-classroom-types-small-groups
    a. Types of small group activities to try
4. **Gallery walk:** http://www.nsta.org/publications/news/story.aspx?id=52391
5. **Vanderbilt University. Group work: Using cooperative learning groups effectively.** https://cft.vanderbilt.edu/guides-sub-pages/setting-up-and-facilitating-group-work-using-cooperative-learning-groups-effectively/
6. **Heller P, Hollabaugh M**. 1992. Teaching problem solving through cooperative grouping. Part 2: Designing problems and structuring groups. *American Journal of Physics* **60**: 637—644.
7. **Johnson JP, Mighten A**. **2005**. A comparison of teaching strategies: lecture notes combined with structured group discussion versus lecture only. *The Journal of nursing education* **44**: 319–322.
8. **Johnson DW, Johnson RT, Smith KA. 2006**. Active learning: Cooperation in the university classroom (3rd edition). Edina, MN: Interaction.
9. **Kuh GD, Kinzie J, Buckley J, Bridges B, Hayek JC. 2007**. Piecing together the student success puzzle: Research, propositions, and recommendations (ASHE Higher Education Report, No. 32). San Francisco, CA: Jossey-Bass.
10. **Springer L, Stanne ME, Donovan SS**. **1999**. Effects of Small-Group Learning on Undergraduates in Science, Mathematics, Engineering, and Technology: A Meta-Analysis. *Review of Educational Research* **69**: 21–51.

11. **Tanner K, Chatman LS, Allen D**. **2003**. Approaches to Cell Biology Teaching: Cooperative Learning in the Science Classroom--Beyond Students Working in Groups. *Cell Biology Education* **2**: 1–5.
12. **Vygotsky L S. 1962**. *Thought and Language.* Cambridge, MA: MIT Press.
13. **Vygotsky LS. 1978**. *Mind in society.* Cambridge, MA: Harvard University Press.
14. **Wenzel TJ**. **2007**. Evaluation Tools To Guide Students' Peer-Assessment and Self-Assessment in Group Activities for the Lab and Classroom. *Journal of Chemical Education* **84**: 182—186.

GENERATING IN-CLASS DISCUSSION

Strategies for designing good in-class questions:

- Plan key questions to provide structure and direction to the lesson. Spontaneous questions that emerge are fine, but the overall direction of the discussion should be planned.
- Decide on your goal or purpose for asking questions.
- Phrase the questions clearly and specifically. Avoid vague and ambiguous language.
- Adapt questions to the level of the students'.
- Ask questions logically and sequentially.
- In planning, try to anticipate possible student responses, including misconceptions.
- Avoid asking leading questions, which suggest their own answers.
- Ask questions at various levels. Scaffold questions.
    - HARSE Questioning Hierarchy (Penick, Crow and Bonnstetter, 1996):
        - History – questions that relate to students' experience
        - Application – questions that require students to use knowledge in new contexts
        - Relationships – questions that engage students in comparing ideas, activities, data, etc.
        - Speculation – questions that require thinking beyond given information
        - Explanation – questions that get at underlying reasons, processes and mechanisms
    - Bloom's Revised Taxonomy (Bloom, 1956)
        - Remembering – recalling information
        - Understanding – explaining ideas or concepts
        - Applying – Using information in another familiar situation
        - Analyzing – Breaking information into parts to explore understandings and relationships
        - Evaluating – Justifying a decision or course of action
        - Creating – Generating new ideas, products, or ways of viewing things
- After class, take note of how your prepared questions went to help improve the discussion in future iterations of the course.

Strategies for increasing student participation:

- Early in the course set expectations for class interaction and explain the value to the learning process. Get broad participation from students within the first week.
- Utilize student names. Learn the names if you can. If you cannot learn all the names, you can ask student names when they contribute a key point and then refer to their response by attributing it to the student.
- When students do not respond, try redirecting the question, rephrasing or scaffolding down to a lower level question. Do not answer the question yourself and move on, as this communicates to students the expectation that your questions are rhetorical and you do not expect participation.
- Be welcoming of all student responses. Use body language, eye contact and other non-verbal feedback to show your respect for students' contributions. Reinforce correct answers. Avoid overly praising correct responses over incorrect ones, as it can lead to reluctance to participate for less confident students. Pay particular attention to provide appropriate reinforcement for reluctant participants the first few times they offer responses. Avoid interrupting students.
- Follow up on students' responses. Elicit longer, more meaningful and more frequent responses from students by:
    - Maintaining deliberate silence
    - Making a declarative statement
    - Making a reflective statement on what the student said
    - Declaring perplexity over the response
    - Inviting collaboration or comments from other students
    - Asking another student to restate or rephrase the prior student's response
- Give students time to think after posing a question.
    - According to Rowe (1974), when teachers allowed 3-5 seconds of wait-time:
        - The number of students who failed to respond when called on decreased.
        - The number of unsolicited but appropriate responses increased.
        - The length of student responses increased.
        - The number of student statements where evidence was used to make inferences was increased.
        - The number of responses from lower-performing students increased.
        - The number of student-to-student interactions increased.
        - The number of student questions increased.

Strategies for encouraging good questions from students:

- Instead of asking "Are there any questions?" try "What questions do you have?" or "Which part is most unclear?"
- Allow sufficient wait time for questions.
- Set expectations early in the course for the role of student questions in the class. When should they be asked, why are they valuable, etc.
- Plan to solicit questions at pre-determined points in your class.
- Be on the look-out for non-verbal feedback indicating student confusion and solicit questions at those points.

- Collect the "muddiest point" from students. This could be done at the end of class, after a key section in class or prior to class, based on readings or homework. This encourages good reflective learning processes.
- There are several good strategies for responding to student questions, including:
    - Answer the question yourself.
    - Redirect the question to the class.
    - Attempt to help the student answer his own question.
    - Ask the student to stop by after class to discuss the question.
    - Refer the student to a resource where he/she can find the answer.
    - Defer the question until a more appropriate time in the course.
    - Say you "do not know" and ask if someone in the class knows, propose a plan for discovering the answer, or volunteer to find the answer and report back.

Additional useful resources and references:

1. **TIDES teaching portal:** https://cns.utexas.edu/teaching-portal/
2. **Faculty innovation center:** Checks for Learning During Instruction https://facultyinnovate.utexas.edu/sites/default/files/ChecksforLearning-DuringInstruction.pdf
3. **Questioning Strategies:** http://citl.illinois.edu/citl-101/teaching-learning/resources/teaching-strategies/questioning-strategies
4. **Asking Questions to Improve Learning:** http://teachingcenter.wustl.edu/resources/teaching-methods/participation/asking-questions-to-improve-learning/
5. **Row MB. 1974.** Wait-time and rewards as instructional variables, their influence on language, logic, and fate control: Part one-wait-time. *J. Res. Sci. Teach.*, **11**: 81–94.
6. **Penick JE, Crow LW, Bonnstetter RJ. 1996**. "Questions Are the Answers." *Science Teacher* **63**, 1: 26-29.
7. **Menke DJ, Pressley M. 1994**. "Elaborative Interrogation: Using 'Why' Questions to Enhance the Learning from Text." *Journal of Reading* **37**, 8: 642-645.