**Group/Team Work in STEM Courses:**
**Some resources and ideas for constructive and inclusive group facilitation**

As we all know, working on teams is both a characteristic of many STEM courses as well as a common feature of most research groups. Building skills for collaboration prepares students for nearly all future careers and is required in most areas of STEM. Thus, we need to help students understand that actively developing their group collaborative skills will increase their communication, problem solving, leadership, and conflict resolution abilities as well as increasing their learning. These skills are directly transferable as they move forward to graduate programs or to the workforce. Student "buy in" for group work can be motivated by providing them with this context and also letting them know that this is an important attribute we look for when writing our future letters of recommendation for them.

It is necessary for us to help students learn how to effectively work together on teams. Many students (and most first-year students) have not yet acquired the background knowledge or learned methods for constructive team work. Furthermore, when students are not provided structure and guidance, issues of bias, stereotyping, or destructive behaviors may emerge. Indeed, student's social identities (gender, race/ethnicity, nationality) have been shown to impact their experiences and learning in groups (e.g., Eddy et al., 2015). If we want to create a classroom/laboratory/field environment where all students can learn and flourish, we need to attend to our pedagogical practices around group work.

The following resources and guides can help you structure group work in your courses and research teams. A good starting place is the "Instructor Checklist – Group Work" that summarizes literature-based recommendations for implementing extended, formal group work. We have also included a set of resources for drafting ground rules for group work with your students. Even if your class time is limited, developing a list of ground rules with your students can help ensure open, respectful dialogue and higher levels of participation among your students. Finally, a longer list of vetted resources and tools are given that you may be able to use or adapt for your specific course.

CBE Life Sciences Education

Feature: Evidence-Based Teaching Guide to Group Work

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# INSTRUCTOR CHECKLIST – GROUP WORK

The following summarizes literature-based recommendations for implementing extended, formal group work. The statements below include areas of ambiguity or disagreement in the literature. Summaries of the articles leading to these recommendations can be found in the LSE Feature: Evidence Based Teaching Guides.

GROUP FORMATION

- ❑ Compose gender-balanced, ethnically diverse groups consisting of students with a mixture of problem-solving styles. Groups with these characteristics exhibit enhanced collaboration. However, there is less consensus on how to form groups of students based on achievement.
- ❑ Instructors rather than students should form groups. Student self-selected teams are more likely to be given as examples of students' worst group experiences, are more often linked to negative student opinions of the course, instructors, projects, classmates, and are more likely to lead to clique behavior. Students did express greater enthusiasm, communication, and conflict resolution in self-selected teams compared to teams that are randomly assigned.
- ❑ Limit the size of groups to 3-5 students. Smaller teams have less difficulty coordinating effort and experience less social loafing, which occurs when not all group members are needed to complete the task. The smaller the group (e.g., pairs vs. 6-7) the more likely all students are to participate in the work and engage in meaningful interactions.

SETTING GROUP NORMS AND STRUCTURES

- ❑ Provide an opportunity for students to discuss their initial expectations for group work in your course, including what they hope to get from interacting with their peers. This initial discussion allows students to express reservations, share prior experiences, and devise methods to express and remedy dissatisfaction as the group work proceeds. Make sure that students understand that when they see that groupmates are not doing their part, they must speak with them. If groupmates continue to be non-cooperative, students must contact the professor. Creating a group contract for a project can aid in this process. Resources can be found at: https://cns.utexas.edu/teaching-portal/group-work
- ❑ Encourage students to consider the channels of communication they will use to interact with their groupmates, such as email, Facebook, in-person meetings, or phone calls.
- ❑ Assign or have students select particular roles. If each of these roles is essential for task completion, students will necessarily depend on each other, promoting cooperation, and instructors can check that all the members are active and participating on a shared document space, classroom management system, or through acknowledgements sections on each assignment.

ENVIRONMENT AND TECHNOLOGY

- ❑ Be sure to consider the materials required for students to perform the task (physical space, site lines, learning resources, handouts, collaboration tools, whiteboards, etc.)

ACCOUNTABILITY

- ❑ Ensure equal participation by requiring submission of individual contributions prior to allowing students to work collaboratively. Students' achievement and cooperation are greater when they understand that everyone must contribute if the group is to complete its goal.
- ❑ Create milestones and deadlines for groups but also provide time for the students to expressly assign duties and roles to meet those deadlines.
- ❑ Provide opportunities for formative peer evaluation: Performance improves when students know that their contributions can be identified. Students believe that evaluating their peers reduces free-riding, but evidence that peer grading reduces free-riding is inconsistent. Formative evaluation provides opportunity for instructors to address problems rather than relying on summative end-of-semester evaluations that may encourage students to tolerate bad behavior and exact retribution later. Also, students rate other factors—including group cohesiveness, small team size, the option to divorce a team member, or the option to leave a team—as having a stronger effect on reducing lack of effort by free-riders than peer evaluations.

REWARD STRUCTURE

- ❑ Reward both individual and group outcomes. Placing students in situations in which success on a task depends on success for all members of the group increases students' motivation, encourages students to help others learn, and results in greater learning gains. Rewards can consist of shared grades where individual students earn a final grade that relies on scores earned by their team members on a test or assignment, to certificates of recognition that students can earn if their average team scores on quizzes or other individual assignments exceed a pre-established criterion.

TASK STRUCTURE

- ❑ Promote student buy-in and learning by sharing the goals of group work with students and explaining how group work aligns with those goals.
- ❑ Consider tasks that involve complex or ill-structured problems for which the benefits of collaboration have demonstrated support for learning. Formalized pedagogies include Problem-based, Team-based, Process-Oriented Guiding Inquiry, Case-Based, and Peer-Led Team Learning.
- ❑ Increase students' intrinsic motivation by selecting tasks that inherently interesting to the student (e.g. related to contemporary issues or representing tasks relevant to their careers) and include opportunities for autonomy and individual choice.

Instructors who desire a less structured approach can find additional suggestions for informal group work in the LSE Feature: Evidence-Based Teaching Guide to Group Work.

**Ground Rules and Expected Behaviors**

Consider providing students with a few ground rules that you expect for engagement with each other (e.g., Listen actively -- respect others when they are talking). A good practice is to allow additional rules to be developed by the class as a whole to show students that you value their perspectives and that you would like for them to value each other. There are a few good resources for formation of a set of norms expected for classroom and group interaction below.

- **Group Setting, Structures, and Norms**: this part of the Group Work Evidence-based teaching guide helps with Setting group norms. https://lse.ascb.org/evidence-based-teaching-guides/group-work/group-setting-structures-and-norms/#norms
- **Setting Ground Rules for Classroom Discussions:** see page 9-10 for a nice guide for setting ground rules and responding to violations of ground rules. https://equity.ucla.edu/wp-content/uploads/2016/06/CreatingaPositiveClassroomClimateWeb-2.pdf
- **Ground rules guide:** this guide also gives a method for helping students create their own ground rules https://www.cmu.edu/teaching/solveproblem/strat-dontparticipate/groundrules.pdf
- **Guide for setting ground rules**: has some widely used ground rules that can be adapted for any context. http://www.edchange.org/multicultural/activities/groundrules.html

You might consider having some teamwork learning goals. These can be evaluated through self-assessment, peer-assessment, and/or instructor assessment. Examples might include:

1. Students will demonstrate effective communication skills with faculty, peers, and other professionals.
2. Students will demonstrate the ability to interact with peers and engage them in the process of learning as part of the team approach.
3. Students will demonstrate respect for others, honesty, a consistently good work ethic, positive attitude, full participation, and responsibility in the educational process as well as in the collaborative community.

You might also consider noting how you will engage students on your syllabus to demonstrate to students that you are also accountable for an inclusive learning environment. Here is an example statement:

I am committed to affirming the identities, realities and voices of all students. This course values the use of person-centered language and preferred gender pronouns, and respect for the experiences of others. Your experience in this course is important to me and I will do my best to help create an inclusive learning environment where all students can thrive. I strongly believe that all students at Bates can be successful in science and that it is my job to partner with you to help you achieve our learning goals.

**Important Resources**:

- **Group Work** is and evidence-based teaching guide published in CBE Life Sciences Education by Wilson, Brickman, and Brame. The guide has references to research studies on group work as well as actionable advice for instructors.
    - You can find the paper here: https://www.lifescied.org/doi/full/10.1187/cbe.17-12-0258
    - Evidence-Based Teaching Guide – each node has references to papers and tips for constructing group work: https://lse.ascb.org/evidence-based-teaching-guides/group-work/
    - Instructor Checklist for literature-based recommendations here: https://lse.ascb.org/wp-content/uploads/sites/10/2018/01/Instructor-Checklist-Group-Work.pdf
- **Surviving Group Projects** is an online module created by University of Minnesota's Center for Educational Innovation. It was created with students and looks like a fun way for students to agree on roles, policies, and tasks as they create a plan for their work. https://teamwork.umn.edu/
- **Diversity, Equity, and Inclusion Tools for Teamwork**: Asset Mapping and Team Processing Handbook was published by Pfeifer and Stoddard at WPI. The guide has three well-described modules that you can adapt directly into your course for groups working with each other throughout the semester (e.g., lab teams, team projects). All of the tools, assignments, and rubrics are spelled out (even how much time they will take).
    - The handbook is here: https://digitalcommons.wpi.edu/cgi/viewcontent.cgi?article=1014&context=gps-research
    - A link to their paper that talks about minimizing stereotyping and task assignment bias: https://www.asee.org/public/conferences/113/papers/22206/view
- **CATME Smarter Teamwork**: This is a tool you can use to help manage groups and allow students to make their groups and do peer evaluation. It costs money and I'm not sure it is worth it unless you have a large class: https://info.catme.org/
- **Social Identities and Student's Experience:** Eddy et al., 2015 https://www.lifescied.org/doi/full/10.1187/cbe.15-05-0108?url_ver=Z39.88-2003&rfr_id=ori:rid:crossref.org&rfr_dat=cr_pub%3dpubmed