Group work: Designing for student participation

Group work is a chance for students to learn from others, to problem-solve collaboratively, and to develop pro-social behaviors. Working regularly in small groups opens up many more chances for students to "talk science" than they would ever get in whole group discussions. The benefits of small group work, however, don't just happen on their own; a teacher has to design opportunities for students to interact with one another in productive ways.

In this guide, we describe four kinds of instructional decisions that help organize collaborative work by young learners. These are shown in the illustration below.

1. Selecting appropriate tasks for group work

Procedural vs. intellectual work

In any type of group activity, you will want to balance students' procedural work and their intellectual work. Procedures are actions taken in some ordered sequence to achieve a goal. Procedures can be about measuring, arranging, drawing, or manipulating equipment or materials. Intellectual work is doing something *with ideas*, or *making decisions* based on science ideas. Below is a list of activities that involve intellectual work; students can:

- make sense of something they have read
- co-construct a representation of an idea (model)
- solve a small-scale problem
- apply existing knowledge to a new situation
- design an investigation
- critique an investigation
- collect, organize, and graph data
- interpret graphs
- develop or revise explanations based on background reading
- examine and weigh out various forms of evidence
- develop an argument for or against a position.
- others…

There is not always a clear distinction between procedural work and intellectual work. Constructing a graph for instance can involve following procedures but this activity can also involve judgments about what type of data should be graphed, what type of graph to create, and how the graph might best show important trends in data.

One mistake that teachers occasionally make is planning for activity without being clear what the intellectual work should be. There is nothing wrong with students doing activities, it's just that too often they can simply follow procedures or memorize vocabulary without thinking about science ideas. Students can "go through the motions" of group exercises without needing to use scientific knowledge or skills.

The different contexts in which to do group activity

Below are a number of situations in which students can work together.

- Students **read an important text together**, using a structured protocol and goals.
- Students do a **lab activity** to help them study some event or process.
- Students in groups **design their own study** (within limits set by teacher and needing to be approved by teacher), collect data, analyze it.
- Students in groups **working with second hand data** (meaning collected by someone else). Examples are data from the health department collected on the cases of asthma in the urban areas OR data on ecosystem populations in Antarctic.
- Students in groups do a **paper and pencil task that simulates real data collection**. Examples are building an energy pyramid in a unit on ecology by passing down "energy" from one level to another. Here they are actually collecting data *from* a model.
- Students in groups do **paper-and pencil activity not to collect data but to understand a concept**. An example is to use a topographic map to understand what a watershed is and its relationship to flora and fauna.
- Students in groups use a **computer simulation to produce data** that could not otherwise be collected. Again, they are actually collecting data *from* a model. Examples are applets on various websites that simulate solar systems, cell division, plate tectonics.
- Students in small groups circulate around room to different **stations** that each are brief demos, but all the stations target the same scientific concept. Examples are stations that demonstrate the Bernoulli effect (low and high air pressure).
- Students act out "**Science Theater**"—physically representing some science idea with their bodies. Examples are molecular motion or interactions between species in a closed ecosystem.

Ways of minimizing student frustration and maximizing engagement

Writing instructions for these types of activities is important. When students are confused about hat to do they can become frustrated, and when frustrated they can shut down (see Appendix A for a list of features in well written instructions).

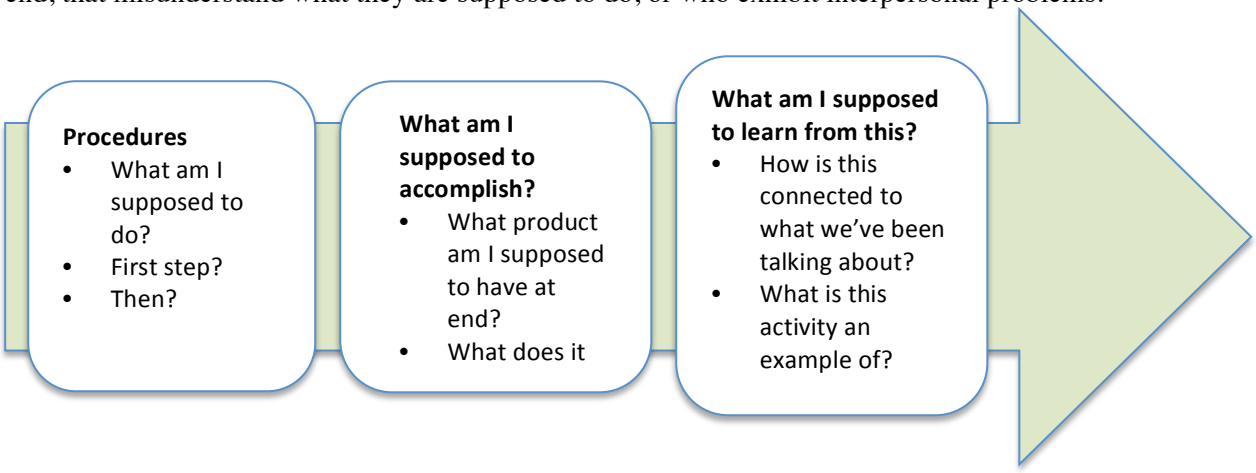
At the beginning of group work make it clear to your students why they are doing this activity (so it's not some disconnected, meaningless exercise) and what the product is that they are responsible for (a concept map, a "solution" statement, a graph, a set of arguments, etc.). The figure below represents what a teacher has to think about here. Write these on the board *and* provide a handout. You don't have to specify *exactly* how to arrive at the final product, but make sure the students have a goal and they know exactly what is expected of them. How much you structure this activity depends on the levels of skill your students have currently.

Some small group tasks allow students to make choices. For example creating situations that promote student-initiated questioning or that allow students to devise their own strategies for experiments/problem-solving tend to increase project ownership *and* collaboration. You can

also give students choices about how to represent data or ideas. Having choices can change a confirmatory activity to one that involves judgment and decision-making.

To keep students on task and on schedule, you can have a mid-point product that they are responsible for, perhaps half-way through the class period (if the group work lasts only one period). If, for example students are supposed to collect data, organize it, and graph it, you may ask that after about 15 minutes they produce an outline for how they will accomplish these tasks.

Within the first 10 minutes of the group work, you should make "the rounds" of your groups and monitor their progress. Don't *just* see if they are "on schedule to finish" or "following directions"— be prepared to listen for clues to their thinking, be prepared to ask probing questions. You also should be able to spot groups who are working themselves into a dead end, that misunderstand what they are supposed to do, or who exhibit interpersonal problems.



A note about what have been referred to as "true group tasks." True group tasks require resources (information, problem-solving strategies, materials, and skills) that *no single* individual could possess so that no single individual is likely to accomplish the task without at least some input from the others. Each member must *exchange resources* with others during the activity. Such true group work is not always feasible in the classroom, especially for short term tasks, but for longer term work, this kind of resource sharing is a good idea.

Some things to avoid in group work of any duration

Don't have students sit in groups and complete worksheets. This is simply "exchanging answers" and does not foster any scientific discourse. Also, don't divide labor so each person does parts of task separately, and the parts only have to be drawn together in the end. This won't foster pro-social outcomes or learning.

Arranging students in groups

The ideal number of students in a group is three or four. If the group size gets too big, it becomes easy for one or more students to "hide," to take on passive roles, and to feel less accountability to the group. If the group size is too big then the material resources cannot be utilized by everyone. This can happen even with a group of three, but it is almost guaranteed with groups of five or larger.

We don't advise having students self-select into groups, otherwise these will fall along friendship lines and inevitably ostracize those who are less popular or less able. You take charge of putting them into groups.

It is best to have groups with mixed ability, gender, and cultural background, but try not to place "token" students in each group. Do not have quotas for each group—students are able to pick up on that strategy right away and are offended by it. There are times when it is best to have English Language Learners who speak the same home language together for small group work, perhaps one student more advanced than the other. But ELLs should not be regularly segregated from the rest of the class.

When the groups are of mixed ability, regardless of the primary language spoken, the more accomplished students can benefit by explaining their thinking to others and the kids who usually struggle can hear how other students organize themselves, how they approach complex problems, and how they seek out relevant resources. This is one of the characteristics of students who usually struggle in class, they do not yet have ways of self-monitoring their own understanding and progress towards a goal and they lack the skills to self-organize. These are *not* "stupid" kids. They just need to see how others do this. Better yet, they can be given opportunities to participate in small ways (initially) in these activities.

Fostering student participation

One of the hallmarks of good group work is that students are *engaged in productive dialogue with each other over science ideas and practices*. But students often don't know how to interact with one another.

To foster group participation, it is helpful to assign roles to students. Roles should NOT be simply about managerial duties, such as the note-taker, the supply-getter, the procedure-reader. Roles SHOULD be about different students taking responsibility for different parts of the science talk that moves everyone's thinking forward. Here are some examples of roles for intellectual work. We list more here than you would assign to a group of students, and you might combine these roles in some cases. What we show below is not "the list" but some suggestions based on our experience in classrooms.

Big ideas person. The BI person pulls the group (occasionally) back to the scientific purpose of the activity (often a group will get too wrapped up in the rote execution of the directions).

- Asks "How does X (something we are studying, reading, investigating, observing, etc.) relate to The Big Idea?"
- Asks: "How does X change the way we're thinking about The Big Idea?"
- Asks: "What is the Big Idea we are trying to understand? Why are we [watching ice melt]?"

Clarifier. This is a role of monitoring everyone's comprehension about one or two key science terms.

- Asks: "Do we know what the word ____ refers to?"
- Asks: **"**Can we put it into our own words?"

Questioner. This person asks probing questions during the activity. These folks listen for questions posed by other group members and then re-voice the questions to make

sure that the whole group takes a moment to hear and entertain questions from everyone. This is not a role that students find easy, so it helps to provide them with question stems such as :

- Asks: "What does it mean that ____?"
- Asks: "How do we know that_____?"
- Paraphrases what other have said: "So, what I think you are saying is… Is that right?"
- Asks: "What would happen if we changed ____?"
- Asks: "What's your evidence?"

Skeptic. This person tries to strengthen the group's work by probing for weaknesses in the developing explanation or model.

- Says: "Here's an alternative explanation—is this just as good as the one we have now?"
- Asks: "Does it always work this way (the explanation)?"
- Asks: "How does our idea match up with what we've just learned?"

Progress monitor. This person ask others to periodically take the measure of the group's progress.

- Asks: "What can we say we've accomplished so far?"
- Asks: "What do we still need to know/do to accomplish this task?"
- Asks: "What can we now add to our explanation that we didn't have before?"
- When you stop by a table to listen in on a group, you should expect this person to be able to communicate the ideas of the group members AND attribute ideas to particular people (giving credit where it is due).

You can sometimes incorporate the "peacekeeper role" into one of the other roles described above.

Peacekeeper. This person monitors airtime of people in the group— this person is allowed to control who has "the floor" with the goal of ensuring that everyone gets a chance to talk and that everyone takes time to listen.

As a teacher, you certainly don't need all of these roles in a group, perhaps just two or three. Sometimes students will play multiple roles and do so spontaneously. This would obviate the need for roles. But in lower grades you will often see kids who have no idea how to work socially within groups, particularly lacking the ability to self-organize individually or as a group. In this case, roles are good to structure their participation.

Playing out roles can be "clunky" in class, but roles do support equitable forms of participation and learning. They can function like protocols for how teachers participate in professional development sessions—awkward at first, but allowing everyone to participate and keeping the work focused. In classrooms we've see role cards typed out and taped to desks or tables. Each card has a title, a brief description of the role, sentence starters for students and even cues about when to enact these roles during the activity. When roles are first introduced in classrooms, we've seen teachers at the beginning of an activity call out one of the roles to be enacted at that point. The teacher does this again with a different role in the middle of the activity, then again with another role near the end of an activity.

Roles for reading texts together

Roles are good not only for hands-on activity, but they can also help groups of students learn to interpret texts together. We've used three roles for working in small groups with an important and perhaps challenging text. For example, one of the roles is the Prompter. Here's the description: "Start off the discussion by stating the questions you are supposed to be working on—or asking someone else in your group to state it. Example of what you might say: *"Who would like to read the question?"* Another role is the Synthesizer. Here's the description: Makes periodic links between different ideas in the text, or asks peers to. *Example of what you might say: "This point in the article reminds me of something else that came earlier (or later)…."* And the third role is the Question Monitor. Here's the description: Asks the group about halfway through if they are really making progress answering the questions that were posed. *Example of what you might say: "Our original questions is…, what progress have we made in answering it?"*

In Appendix B we have the full tool that we use with students when they read texts together.

Interpersonal considerations

Students in middle and high school do not possess all the interpersonal skills necessary to support productive group work. Fostering pro-social behaviors should be a concurrent strategy with the design of productive group tasks. What kinds of behaviors are beneficial to group work?

- Making sure everyone has a significant role to play (both procedurally and cognitively) – this means giving everyone a chance to voice their ideas and opinions.
- Commenting on the ideas of others without commenting on them as people.
- Making ideas public and explicit without at first passing any judgment.
- Building on ideas of others (kids get to listen to the thinking process of others—extremely valuable!).
- Asking on-task questions that go beyond procedures and are about ideas.
- Asking peers to clarify what they mean.
- Peers answering the specific questions asked by their classmates.
- Keeping sarcasm out of the conversation.
- Others?…

As the teachers you should take the time to talk in very plain terms about these principles and give examples and counter examples of each through role play (kids are actually good at this, they do enjoy giving the good and bad examples). You should make a poster of these principles (make your own list with your students' input, ours is not complete or perfect) and hang them up in your classroom. Early in the year, you are really in the business of establishing norms of behavior—what will and will not be acceptable in your classroom. The list above can pertain to whole group discussions as well as small group interaction.

Make students cognizant of these interactions as they happen in small groups. At the beginning of a day of group work, have students focus on one of the principles on your list. At the end of a day of group work, have them report out how they fared in maintaining that norm. Make the pro-social goals equal in importance to the intellectual goals.

Maintaining these norms is critical. Periodically revisit norms; this helps students focus on positive ways in which the group is developing. Students can revise norms and monitor positive ways in which the norms are exemplified.

Maintaining positive group functioning also requires that teachers gradually turn more of the leadership roles over to the students. Examining the list above, we can think about how some of these teacher actions can be gradually turned over to the students.

Planning for assessment and accountability

As mentioned previously, you should make informal and frequent assessments of who in the groups is involved. Involvement means not only in the handling of materials but in the intra-group dialogue as well.

In every class there will be students who will not contribute to the work of the group. Frequent monitoring of the group's activity is one way to head this off. You also can give the group a sheet on which they self-assess their own contributions to the group. You will need to give them examples of what you mean by "contributing to the success of the group." Students can also give group and self-evaluations reflective feedback for specific scientific processes criteria (i.e. making scientific connections, being systematic, reasoning carefully, teamwork, etc.).

Teachers can also help students can take ownership for helping one another. For example, teachers can tell students that they will call upon one member of their group to explain their scientific reasoning. Group members, then, need to make sure everyone in their group understands the ideas before one of them is asked to present it to the class.

For group work that lasts only one class period, you may not have to give students any formal evaluation, as long as their work can be talked about in a whole group setting so that the teacher knows they have been engaged in productive work.

For longer term work however, you will want to have both group and individual accountability. For any major project you must have a rubric that you share with students at the outset of the project. This is used to give some feedback as the project is being worked on. This rubric becomes basis for a group grade. This *group* grade may account for one third of their total final project grade. The students, *as individuals*, may be given some task or questions related to the final project. This individual grade may count as two-thirds of their total final project grade. In a perfect world, all students in a group contribute equally to a project and all can fairly receive the group grade as the total final score. But this is not a perfect world.

Be forewarned that any grading scheme for group work is going to be open to criticism. There is no such thing as total, objective fairness in group assessment. The benefits to well-designed group work however, clearly outweigh the challenges to assessing student progress.

Summary

Being successful in group work can take the form of students' academic achievement, students engaging in productive discourse about science, and students fostering each others pro-social behaviors. Your job as a teacher is to take those disciplined ways of thinking and pro-social ways of relating to one another and get students to "internalize" these behaviors. Your goal is to scaffold students' thinking and social actions so that they can eventually do this collaborative work on their own, without your intervention. Remember, kids are not naturally organized, they do not spontaneously monitor their own progress, they do not naturally use scientifically disciplined ways of thinking, and they do not always know what pro-social

behavior is. It is necessary to make these ways of thinking and acting explicit to them and to help them monitor their own efforts at thinking and acting this way.

Appendix A.

The well constructed activity guide: an "ideal" checklist:

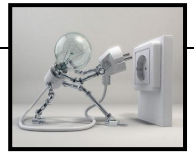
- ❑ A **stated purpose** for the activity that is written in kid language. Should be written more like a learning objective and less like a behavior the kids will engage in. You should include a brief description of the product they will create.
- ❑ **Defines a task** that requires students to work together rather than as separate individuals who only "pool their ideas" at the end of the lesson.
- ❑ Has a **clear place for students to start reading** ("Start here!") and a recognizable sequence to follow (arrows, numbers, graphic flow etc.).
- ❑ If you have **more than one procedure** you want students to engage in, separate them clearly. You can even insert the line "check with me before you move on to the second part."
- ❑ Use **images** to support parts of the activity that are particularly hard to image with them, do NOT put in extraneous or "cute" images.
- ❑ Have **no more than four or five step**s—and give each a name.
- ❑ If students are to **write or draw something**, put a specific place for that and be specific about what you want them to write or draw. Beginning teachers have to learn that students will ONLY give you what you ask for, and not more.
- ❑ If you ask students to do something **intellectually difficult for the first time** (like writing about evidence or making a claim or designing an experiment), *include an example* of it and/or include heavy scaffolding (especially for English Language Learners). This is probably best done not on the document you give them, but posted on a whiteboard or projected—it can be too much text on a handout.
- ❑ Add a **challenge task** if students get done early, or be ready with one on your back-pocket questions. Don't make it a punishment, but rather make it puzzling and do-able in the time allowed. These can be thought experiments or "what-ifs"

Appendix B

3 Intellectual roles to facilitate discussion about text

Start here: Before you begin discussing the articles, each person should state what their role is.

Note: The roles below are in addition to other conversational contributions that you would normally make in the discussion, they are not the only kinds of things you say during the discussion.

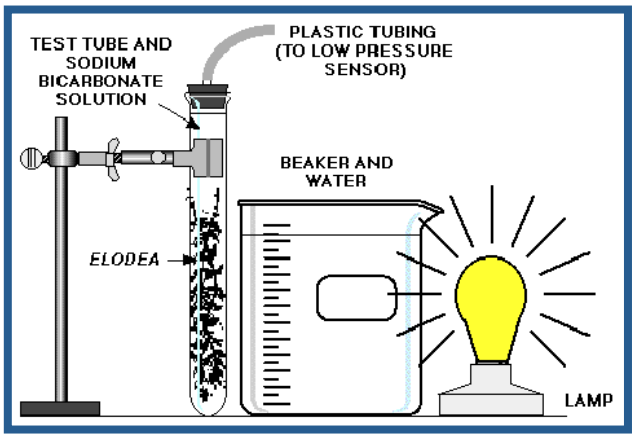
Prompter 	*Synthesizer* 	*Question monitor* 
• Start off the discussion by stating the questions you are supposed to be working on— or asking someone else in your group to put it into their own words. *Example of what you might say: "Who would like to read the question?" OR "Can someone say what the task is in their own words?"*	• Makes periodic links between different ideas in the text, or asks peers to. *Example of what you might say: "This point in the article reminds me of something else that came earlier (or later)…"*	• Asks the group about halfway through if they are really making progress on the task. *Example of what you might say: "Our original questions is…, what progress have we made in answering it?" OR "What do we need to do now to make progress?"*
• Ask your peers if they think they understand what is being asked for. *Example of what you might say: "What kinds of things would we have to talk about to be able to accomplish this task? "*	• Asks two peers to make connections between ideas that they have brought up. *Example of what you might say: "How is what you (peer 1) have said about this topic, similar or different from what you (peer 2) have said?"*	• States what other questions the group has been spending time on, or asks a peer to state it. *Example of what you might say: "Can you give me a list of other related questions that we've been talking about?"*
• Throughout the discussion, ask your group members to elaborate on their answers. *Example of what you might say: "Can you say more about that?" "What do you mean by that?" "Why do you think that?"*	• Makes periodic links between ideas across different texts. *Example of what you might say: "I think that this idea (in Text #1) relates to this idea (in Text #2), because…."*	• At the end of the discussion, prompts others to summarize what progress was made and helps them out if necessary. *You might say: "Can you talk about a couple major responses we have to the question or about the task? Were we successful? Why or why not?"*

Appendix C

Consider This Case

Learning to Labor vs. Learning to Think

We describe a classroom case for you to think about. It is a realistic situation and it may be helpful if you talk about this with your own colleagues, to ask "What choices would we have made here?"



The case: A teacher assigned small groups of students to work on a week-long science inquiry project where students would collect multiple lines of data about metabolic processes carried out by Elodea plants. The project is complex and required that groups juggle a number of different tasks and run a few experiments simultaneously. To help manage the workload the teacher created some roles for students to help delegate responsibilities equally among group members. The first task for the group was to decide who would take on each of the following roles:

- Recorder – This person writes down key info such as data results or summaries of discussion.
- Presenter/Reporter – This person would create a presentation to the whole class of what the group did.
- Materials Manager – This person keeps track of the materials, gets them from the supply table and returns them.
- Group Manager– This person keeps the group on task, reminds them when time is getting wasted and when things are due.

Students negotiated their roles. Susan, a quiet girl with good handwriting, was selected as the recorder. Perry, an outgoing boy was selected as the presenter. Juan, who is still learning English after arriving in the U.S. from Guatemala two years ago, was selected as the materials manager. Whitney and her best friend Kelly decided to share the role of group managers and then started to make decisions about how to get through all of the requirements of the project on time.

During one of the investigations you notice that the groups are tending to talk about how to set up the investigation, where to get materials, how to measure responding variables as they carry out an inquiry. Some of the conversations seem productive because students are asking questions about different variables they can manipulate. None of the groups are talking about the big science ideas as they collect data. One of the "fast-moving" groups is virtually silent as they work and during analysis of the data they do not seem to be talking about the big scientific ideas. One of the "slower-moving" groups can't

seem to come to a consensus about how to collect data and during analysis they seem to disagree as well.

Discussion Questions

1. How do you feel about the group roles and about how particular students are positioned within those roles in this case?
2. Although the teacher was not intentionally positioning students along social stereotypes using this strategy, the group ended up with students in stereotypical roles (such as the girl with "good handwriting" as a secretary, the Latino student setting up/cleaning up equipment, higher status students as presenters and leaders). What kinds of subtle messages does this send to students in the class?
3. Why do the "jobs" in the group matter? (HINT: Try to think beyond "dividing the labor"… What are students learning explicitly or subtly by having these "jobs"? What are certain students excluded from learning when they are positioned in particular "jobs"?)
4. If you were to "re-wind" this group activity and start over, what would be some changes you would make, based on our reading for today?