Using Classroom Assessment and Cognitive Scaffolding to Enhance the Power of Small-Group Learning

James L. Cooper
Pamela Robinson
California State University, Dominguez Hills

The authors describe several types of classroom assessment techniques (CATs) and cognitive scaffolding procedures that they have developed over the years. They then bring the procedures together in a sample lecture/group learning class presentation.

In this article we describe our experiences with using small-group instruction in college settings for a combined total of 60 years. Since others, including Johnson and Johnson (1989), Kagan (1994, 2009), Sharan (1994), and Aronson (2011), have developed specific forms of group work, such as structured controversy, jigsaw, and group investigation, we will focus on how we have used group work as a core technique and have developed additional procedures that seem to potentiate the power of group work, regardless of the specific procedure and discipline.

History

Collaborative learning and cooperative learning are probably the two most common terms used to characterize employing small groups to enhance learning and other outcomes. Because both authors were trained in quantitative methods and were most comfortable structuring the learning environment for our students, we gravitated to what was called cooperative learning. First author James Cooper (Jim) and his colleagues wrote a 1995 article in *Change* (Matthews, Cooper, Davidson, & Hawkes, 1995) distinguishing the differences between cooperative and collaborative

learning in some detail. They suggested that cooperative learning tended to be more structured, with teachers being active in planning, monitoring, and facilitating progress with the groups. Collaborative learning tended to give control to students to decide what to study and how their groups should function (Bruffee, 1995). In the 1980s and 1990s, these operational distinctions seemed important to the research community and to us. When Jim and his colleagues presented an early version of the *Change* article at an AAHE meeting, one audience member indignantly said that our work on this distinction was a form of "mental masturbation." We do think that there are differences between these approaches, but we now believe that the most important characteristic of small-group work is the clarity of how to implement group procedures and how those procedures relate to specific learning outcomes. We don't see a significant current interest in the literature pitting these two "camps" against one another. Nor do we see analytical studies in which value added effects on one element of group work is assessed (for instance, individual accountability) when holding all other elements constant.

Perhaps due to the lack of empirical interest in higher education of the relative impact of cooperative and collaborative learning, we have noted that *cooperative learning* and *collaborative learning* are used rather loosely in the recent literature. Many articles ostensibly discussing cooperative learning do not systematically employ the five critical elements of cooperative learning identified by Johnson and Johnson (1989), or those of others who describe as many as seven (Cuseo, 1992) or as few as four (Kagan, 1994, 2009). For this reason, in recent years, we have chosen to use the terms *small-group instruction* and *small-group learning* as umbrella terms to encompass both cooperative and collaborative learning. (See Cooper, Robinson, and Ball 2003, 2009, and Cooper and Robinson, 2011, for further discussion of these and other issues.)

Two Powerful Small-Group Techniques

We devote the remainder of this article to two powerful techniques that have strong empirical bases and that may be used with a variety of small group procedures to enhance their impact on student success: quick-thinks (Johnston & Cooper, 2003a) and cognitive scaffolding (Johnston & Cooper, 2003b).

Quick-Thinks

Quick-thinks are forms of classroom assessment in which the lecture

and/or other presentation formats are punctuated by questions or issues that require students to process information individually or in pairs or teams. They are similar to Mazur's (1997) ConcepTests in this regard. ConcepTests are multiple-choice items presented to students at frequent intervals during lectures to check for comprehension. Like Quick-thinks, ConcepTests may be used with individual students, pairs, and teams of four or more and with virtually any instructional format and type of group work. Recently, these procedures have been used with clickers (hand-held personal response systems with which students respond) in small and large classes and in distance-learning formats. Research by Mazur (1997) and others using similar techniques indicates that such procedures increase student achievement, liking for the content, critical thinking and class attendance (Osterman, Christensen, & Coffey, 1985; Ruhl, Hughes, & Schloss, 1987). Quick-thinks were developed with a focus on presenting classroom assessments that tapped a number of levels of Bloom's taxonomy, from low levels of thinking, such as the knowledge/rote level, to higher levels, such as synthesis, analysis, and evaluation (Johnston & Cooper, 2003a). The eight quick-thinks listed below are examples of a much larger pool of quick-thinks that could be developed. Additional informal procedures, such as think-pair-share, think-pair-square, timed-pair-square, numbered heads together, and round robin can be found in Cooper et al. (2009), Cooper and Robinson (2011), and Kagan and Kagan (2009).

1. Select the Best Response

This quick-think procedure is similar to a multiple-choice test and to Mazur's ConcepTests. Students are presented with a question or scenario and are given foils or distractors from which they must select the best response. For example, in a psychology class, students might get an item indicating that a professor is having marital problems and, as a result, is giving students low grades. Students might be asked if a psychoanalytical explanation would describe this as an example of (a) repression, (b) projection, or (c) displacement. (The correct answer is c.)

2. Correct the Error

In this classroom assessment, students are presented with an intentional error that they must correct. In a teaching methods class, students might get an item indicating that a learning outcome (LO) is what the teacher will cover in class. (In fact, an LO is what the students will do to demonstrate competence.)

3. Complete a Sentence Starter

In this quick-think, students are presented with a sentence stem that they must complete. This technique can be used for lower-level recall information as well as higher-level cognitive skills, such as analysis or evaluation. In a criminal justice or public policy course, students might be asked to list implications of California's "three strikes" law. Possible responses could include prison overcrowding, pressuring judges to make exceptions, requiring construction of new prisons, and/or reducing crime rates.

4. Compare or Contrast

In this procedure, students are presented with two or more parallel elements from a lesson and are asked to find similarities or differences in the content. Work by Marzano, Pickering, and Pollock (2001) indicated that this type of item was very effective in fostering a deep level of under-standing of complex content. In an art appreciation class, students could be shown Joan Miro's 1933 *Composition* painting and the 1950 Jackson Pollock work *One*. Students might be asked to list elements of the two paintings that are *similar*. Their answers might include fluidity of design, nonrealistic content, and/or impression of movement.

5. Re-Order the Steps

In this quick-think, a number of steps in a procedure are presented in random order, and students are asked to place the steps in the correct order. This technique is useful in labs and practica, such as nursing and clinical science. In a psychology lab, students might be given the task to correctly order the conditioned stimulus, the conditioned response, the unconditioned stimulus, and the unconditioned response in a classical conditioning (Pavlovian) experiment.

6. Support a Statement

In this task, students are to support a statement given by the instructor using their class notes or other resources. Rather than adopting a passive posture toward course content, students are asked to justify a statement. For example, in a geography class, students might have to respond to an item such as this: "Warfare has historically had a devastating impact on the earth's resources. Give three pieces of evidence to support this statement."

7. Reach a Conclusion

This quick-think procedure asks students to make a logical inference about the implications of facts, concepts, or principles they just learned. A number of responses can be derived from this quick-think that may be used for team or classroom discussion. For example, in an earth science class, students might be asked, "If you can scratch the smooth surface of a mineral with a tempered-steel file but not with a piece of glass, you could conclude. . . ." Students' responses might include that the mineral cannot be quartz, topaz, corundum, or diamond, or that the mineral has a hardness rating between 6 and 10 on Moh's scale.

8. Paraphrase the Idea

This technique requires students to rephrase an idea in their own words. Often it is helpful to have to students structure their responses to a specific audience, such as a parent, a fellow graduate student, or a client. An example of this Quick-think in an education class is this: "Explain to a parent what his daughter's score of 47th percentile in reading means in terms of norm-referenced testing."

Cognitive Scaffolds

Johnston and Cooper (2003b) define scaffolds as forms of support temporarily offered by instructors when introducing new content and making assignments. Once content is mastered, such support can be removed. Johnston and Cooper identified the five scaffolds described below while acknowledging that many more are possible. (See Rosenshine and Meister, 1995, for additional information.)

1. Comprehension Checks

Comprehension checks are brief thinking tasks inserted into lectures or other presentation formats to ensure that both students and instructors have opportunities to check on the comprehension of material as it is being explained. Quick-thinks and ConcepTests are examples of comprehension checks. We insert comprehension checks into our lectures every 15-20 minutes. Students can check their understanding before additional content is presented, and faculty can assess students' mastery before proceeding to additional content (or reteach if mastery is not demonstrated). For example, in a lecture on sampling methods in research, students might be taught three types of sampling and then tested on them. If students demonstrate mastery of those three procedures, three additional techniques are

presented, and students are then given a comprehension check on all six. By having course content broken into manageable "chunks," students are much more engaged in lecture material that they may otherwise view as technical and tedious.

2. Anticipate Student Errors

As Johnston and Cooper (2003b) note, teachers can use their prior experience in teaching to pinpoint common student mistakes and to address them as the content is being presented, instead of waiting for students to make them on a test or paper. For example, after he teaches frequency distribution in his research methods and statistics classes, Jim has students draw examples of frequency polygons (for example, the normal curve) before he moves on to correlation coefficient scatterplots. Over the years, Jim has noted that these two statistical pictures are commonly confused. Once mastery of the frequency polygon is demonstrated, Jim draws the X and Y axes of a correlation scatterplot and notes that score and frequency information would be placed on the X and Y axes if a frequency polygon were to be drawn. But in the new content ((correlation), the focus is not on frequency information, but on how one score for a person relates to another score for that same person (that is, correlation). Jim draws the score information on both axes for this new picture, precorrecting a common mistake made by students, before going into the new conceptual content of correlation.

3. Partial Solutions

As Johnston and Cooper (2003b) note, "Partial Solutions involve presentation of a complex task that is already partially completed by the instructor so that students can more successfully complete the tasks by focusing on only a few elements while trying to assimilate new information" (p. 138). For example, when introducing frequency polygons, Jim first draws a polygon graph, labeling the axes and drawing the data on the graph. Then he asks students to draw another polygon picture. He shows his students how to label the X and Y axes for the new graph, then has them fill in the data points on the graph and check their pictures and labels with another student. Only after this does Jim have students draw *and* label a frequency polygon "from scratch" and share this third drawing with a classmate.

4. Think Alouds

In this procedure, the instructor verbally models how an advanced

practitioner might solve a problem or address an issue. In the sampling module of a research methods and statistics class, after presenting stratified and purposive sampling, the instructor might give a Quick-think, such as " A researcher wanted to assess the impact of the Open Court reading program on at-risk students, so he picked the 40 lowest-achieving students to participate in a pilot study. Is this an example of stratified or purposive sampling?" The teacher might say, "In stratified sampling I want to ensure that two or more levels of a characteristic in the population are also represented in a sample. So, if I had high, medium, and low achievers in the population and ensured that all three levels were represented in the sample, that would be stratified sampling. But in the example I began with, just the *lowest* achieving students were selected. Purposive sampling, as we previously discussed, is when one homogeneous group is selected, and the example seems to be purposive because just the lowest achieving students, not high-, medium-, and low-achieving students, were selected."

5. Procedural Guidelines

Johnston and Cooper (2003b) indicate that Procedural Guidelines "function as concrete references students can rely on for support as they attempt to complete new and complex tasks" (p. 144). For example, in an assignment to develop a proposal for a qualitative study, Jim has his students engage in the following activities: (1) Develop a general goal for the study; (2) construct specific research questions within that goal; and, finally, (3) develop a methodology for each research question, including a sample, a timeline, and a data collection procedure (for example, observation, interview, videotaping). By having broken this complex task into individual and sequential elements, students have a template to use in addressing a complex task that is not widely understood by students.

Putting It Together: The Interactive Lecture

Over the years, we have taught using the quick-thinks and scaffolds identified above. The fundamental idea that emerged from our collaboration and reading the literature on research-based active learning resulted in a technique in which we teach using a lecture format that is tightly linked to explicit objectives. Every 15-20 minutes, we stop our lectures and insert a short quick-think or scaffold related to a specific learning objective in order to foster deeper processing of course content. As we have developed this technique, which became the interactive lecture, we noted that others have developed similar approaches, and some had tested their versions of the interactive lecture and found positive results

in terms of course achievement (Osterman et al., 1985), critical thinking and course attendance (Mazur, 1997), and other measures. Johnson and Johnson (1989), Bligh (2000) and Gibbs (Gibbs & Jenkins, 1982) have developed similar approaches to the interactive lecture.

The following example illustrates what the interactive lecture might look like in a three-hour weekly course in research methods. We are confident that readers will see how the approach may be adapted for other content areas, class lengths, and presentation formats:

A Typical Class

> Dr. Caitlin Robinson, a second-year teacher, enters her graduate Research Methods and Statistics class with a sense of anticipation. During her first year things had not gone too well in this class, which is perceived by most students as difficult, content dense, and less than compelling. Last year she had lectured for the three-hour class without knowledge of the literature on active and small-group learning. This year she vows to use the information acquired in her reading about the research on effective teaching and the workshops she attended on active learning and student engagement.

> Caitlin begins her class in week 7 of the current semester by briefly reviewing previous course content and describing the content for this week's class. She is assisted in this review by reading a quick-think, commonly known as the minute paper. Last week, at the end of class, she had students submit a slip of paper on which they identified the most important thing they had learned during that class meeting and what content was least clear to them. Caitlin had read the minute papers right after last week's class, and her own impressions of what went well and what didn't had not only been confirmed, but it was also revealed that some students were confused about an additional concept that she had thought they all had understood.

By reviewing previous content and previewing new content in week 7, Caitlin encourages metacognition in her students, as they put previous lecture content into their existing knowledge base and make a link to this week's new information. Many teachers simply launch into new content each week without knowing what students currently know (or don't know). Taking a few minutes to review and preview tends to pique students' interest regarding the content of that week's class, making it a powerful strategy. Ausubel (1960) calls this an advance organizer.

> It turns out that the minute paper revealed that many students were unclear about the portion of the week 6 lecture dealing with

frequency polygons, a drawing in which the number of scores are visually depicted (e.g., the number of students scoring in the 60s, 70s, 80s, and 90s on the Iowa Test of Basic Skills standardized test). Caitlin begins her class this week with a frequency polygon by labeling the X and Y axes and adding a set of data. Then she says, "Now you try it." She gives the students a new set of data and labels the new graph, but she has the students make the actual drawing.

By labeling the X and Y axes for the drawing, Caitlin has partially worked the problem (the cognitive scaffold of partial solutions) before asking students to do the work "from scratch" (both labeling and drawing the graph). This allows students to focus on the content and major objective of the lesson (how many students scored in each interval of scores).

After students complete the task, Caitlin has students turn to a neighbor and compare and discuss the graphs each has done, a type of Comprehension Check. She passes among students as they conduct this Comprehension Check, observing each pair and answering questions. Then she draws the correct graph on the board.

This sequence of instruction demonstrates the Model-Practice-Feedback loop, a process shown to foster deep processing of course content (Rosenshine & Meister, 1995).

When Caitlin begins this week's new content (correlation), she presents a data set relating student self-esteem to achievement. She starts by drawing a blank graph with X and Y axes on the whiteboard and asks her students, "If I were going to make a frequency polygon, what kind of information would I label on the X and Y axes?" Since students did a number of frequency polygons last week (during lecture and in four person cooperative learning groups), and they just reviewed frequency polygons at the beginning of this meeting, many of them correctly respond that score intervals go on one axis and frequency of scores on the other. Caitlin then tells them that today the class will focus on a statistical drawing that superficially looks like a polygon, but gives very different information: the extent to which two variables are correlated or associated with one another. She then completes the labeling and drawing of a correlation scatterplot for the self-esteem and achievement data and explains it. Caitlin then lists another set of data for a new correlation scatterplot and explains that she will put score information on both axes, unlike the frequency and score information used on frequency polygons. She notes that many students commonly confuse the

> two graphs and warns them that today they will be drawing
> scatterplots that have score information on both axes.

Noting how the two graphs are different in the labeling and the information presented is a form of the quick-think task compare or contrast. Identifying how two concepts are similar and how they are different has been identified as a powerful technique for fostering deep levels of achievement (Marzano et al., 2001). It also is an example of the cognitive scaffold anticipate student errors, because she is forewarning them of a common error students make when labeling the correlation graph after practicing the polygon graph in previous classes.

> After lecturing on correlation, Caitlin asks students to explain,
> in their own words, the kind of information presented in a
> correlation scatterplot. Several students say that each "dot" on
> the graph usually represents how individual people performed
> on two variables.

This strategy can be considered an example of the quick-think task paraphrase the idea, because it calls for students to take a technical idea and describe it to another person in their own words. This task is more difficult and requires a deeper level of processing than drawing and labeling a scatterplot. The previous week, Caitlin had her students explain what information is conveyed in a frequency polygon to another student. When students explain these concepts, they engage in cognitive elaboration (Reigeluth & Stein, 1983), which has been shown to foster higher order thinking skills that are retained longer than just completing rote tasks (Rosenshine & Meister, 1995).

> During the second half of class students work in teams of four,
> answering problem sets on correlation, frequency polygons
> and other content covered in several previous class meetings.

These comprehension checks cognitive scaffolds alert students and the teacher to material still not mastered so the teacher can reteach content. The better students can provide think alouds as cognitive scaffolding for other students.

> Toward the end of class, Caitlin goes over the answers to all the
> problems answered in teams.

We have used elements of the interactive lecture in many different courses in education and psychology at both the undergraduate and graduate levels and have seen it used in many other courses. Students tend to be highly engaged in this form of pedagogy, because it takes

what is often viewed as a difficult subject and breaks it into manageable chunks of information with appropriate practice, an approach that is consistent with how the brain processes information—as opposed to the lecture method, which is generally incompatible with how information is processed (Kagan, 2009).

Conclusions

Quick-thinks and cognitive scaffolding can be used in lectures, discussions, laboratories, and other pedagogies. They can be used with cooperative and collaborative learning and the many specific types of these general approaches, including jigsaw, group investigation, structured controversy, and others. We invite readers to begin applying the techniques noted above to their teaching by using one or two strategies and gradually increasing the number of techniques as they experience success. The Interactive Lecture, Quick-thinks, and scaffolding have transformed our teaching, and the teaching of hundreds of colleagues we have worked with over the last few decades, into interactions with exciting and engaging communities of learners in our classrooms.

References

Aronson, E., & Patnoe, S. (2011). *Cooperation in the classroom: The jigsaw method* (3rded.) London, UK: Pinter & Martin.

Ausubel, D. P. (1960). The use of advance organizers in the learning and retention of meaningful verbal material. *Journal of Educational Psychology*, *51*(5), 267-272.

Bligh, D. A. (2000). *What's the use of lectures?* San Francisco, CA: Jossey-Bass.

Bruffee, K. (1995). Sharing our toys: Cooperative learning versus collaborative learning. *Change: The Magazine of Higher Learning, 27*(1), 12-18.

Cooper, J., & Robinson, P. (Eds.). (2011). *Small group learning in higher education: Research and practice.* Oklahoma City, OK: New Forums Press.

Cooper, J. L., Robinson, P., & Ball, D. (Eds.). (2003). *Small group learning in higher education: Lessons from the past, visions of the future* (1st ed.). Oklahoma City, OK: New Forums Press.

Cooper, J. L., Robinson, P., & Ball, D. (Eds.). (2009). *Small group learning in higher education: Lessons from the past, visions of the future* (2nd ed.). Oklahoma City, OK: New Forums Press.

Cuseo, J. (1992). Cooperative learning vs. small-group discussions and group projects: The critical differences. *Cooperative Learning and College Teaching, 2*(3), 4-5, 8, 10.

Gibbs, G., & Jenkins, A. (1992). *Teaching large classes in higher education: Maintaining quality with reduced resources*. London, UK: Kogan Page.

Johnson, D. W., & Johnson, R. T. (1989). *Cooperation and competition*. Edina, MN: Interaction.

Johnston, S., & Cooper, J. L. (2003a). Quick thinks: Active-thinking in lecture classes and televised instruction. In J. L. Cooper, P. Robinson, & D. Ball (Eds.), *Small group learning in higher education: Lessons from the past, visions of the future* (1st ed.) (pp. 122-134). Stillwater, OK: New Forums Press.

Johnston, S., & Cooper, J. L. (2003b). Supporting student success through scaffolding. In J. L. Cooper, P. Robinson, & D. Ball, (Eds.), *Small group learning in higher education: Lessons from the past, visions of the future* (1st ed.) (pp. 135-145). Stillwater, OK: New Forums Press.

Kagan, S. (1994). *Cooperative learning*. San Clemente, CA: Kagan.

Kagan, S. (2009). Cooperative-learning structures for brain-compatible instruction. In J. Cooper, P. Robinson, & D. Ball. *Small group learning in higher education: Lessons for the past, visions of the future (2nd ed.)* (pp. 292-310). Oklahoma City, OK: New Forums Press.

Kagan, S., & Kagan, M. (2009). *Cooperative learning*. San Clemente, CA: Kagan.

Marzano, R. J., Pickering, D. J., & Pollock, J. E., (2001). *Classroom instruction that works*. Alexandria, VA: Association for Supervision and Curriculum Development.

Matthews, S. R., Cooper, L. J., Davidson, N., & Hawkes, P. (1995). Building bridges between cooperative and collaborative learning, *Change: The Magazine of Higher Learning, 27*(4), 25-30.

Mazur, E. (1997). *Peer instruction: A user's manual*. Upper Saddle River, NJ: Prentice Hall.

Osterman, D., Christensen, M., & Coffey, B. (1985). *The feedback lecture* (IDEA paper No. 13). Manhattan, KS: Kansas State University, Center for Faculty Evaluation & Development.

Reigeluth, C., & Stein, F. (1983). The elaboration theory of instruction. In C. Reigeluth (Ed.), *Instructional design series and model* (pp. 335-379). Hillsdale, NJ: Erlbaum.

Rosenshine, B. V., & Meister, C. (1995). Scaffolds for teaching higher-order cognitive strategies. In A. C. Ornstein (Ed.), *Teaching theory into practice* (pp. 134-153). Boston, MA: Allyn & Bacon.

Ruhl, K. L., Hughes, C. A., & Schloss, P. J. (1987). Using the pause procedure to enhance learning recall. *Teacher Education and Special Education, 10*, 14-18.

Sharan, S. (1994), Group investigation in the university classroom. *Cooperative Learning and College Teaching, 4*(2), 10-12.

James L. Cooper *has published five books and over 75 chapters, monographs, and articles, most of which have focused on research-based active learning in college classrooms. He recently retired from California State University, Dominguez Hills, where he taught for 38 years and where he held several administrative positions, including director of faculty development and coordinator of the teaching/curriculum M.A. program.* **Pamela Robinson** *has been a faculty member at California State University, Dominguez Hills since 1992. Her research and publication focus has been on effective teaching strategies, including active learning techniques. She is currently the evaluation coordinator for the College of Education, where she teaches both undergraduate and graduate courses.*