This interview with Karl Smith, Associate Professor of Civil and Mineral Engineering at the University of Minnesota, took place on the campus of Arizona State University on March 26, 2001.

Susan Ledlow: I'm here today with Karl Smith, Associate Professor of Civil and Mineral Engineering at the University of Minnesota, who has been a tremendous influence on the Foundation Coalition Engineering Education project. Karl, I'd like to start by asking you how an engineer came to be the author of a number of books on cooperative and active learning.

Karl Smith: I got started thinking about teaching and learning during the first course that I taught in engineering at the University of Minnesota, when I was just very frustrated and felt there had to be a better way of helping students learn than what I was doing. For example, after giving a pretty good lecture—or what seemed to me was a good lecture—students would come with questions that indicated they didn't have a clue about what I was talking about. And I felt that there had to be better ways of [teaching]. So I started exploring, and taking courses in the College of Education, and that's how I got started writing and thinking about that.

Ledlow: Tell us a little bit about your collaboration with David and Roger Johnson.

Smith: That was luck and proximity—the wonderful thing about proximity. I took several courses in the College of Education to try to learn more about how people learn and effective practices in teaching and learning, and I almost gave up—because there was a lot of measurements, statistics, evaluation, which was interesting—but it wasn't helping me get a sense of how I might help students learn. Then I stumbled into one of David Johnson's courses—actually it was taught by a graduate student—a course called The Social Psychology of Education. And in that course he had us working in formal teams, and I thought, "This is what we do in engineering; this will work for me." And so that was the "Eureka!" experience, starting my work with Dave and Roger Johnson.

Ledlow: And you actually, in addition to being an engineer, have a Ph.D. in Educational Psychology?

Smith: Yes, I like the academic environment. I was hired at Minnesota mainly to do research. I worked in a research lab and taught an occasional course. I liked the environment and then was told I needed an 'academic union card'—a Ph.D. And so I started exploring and thought, "Oh gosh, I do this engineering research work all day; why I don't I do something else evenings and weekends?" And then I proposed to do a Ph.D. in Educational Psychology. The thing that intrigued me initially, and the connection with engineering, was work on expert systems and artificial intelligence. Those were the folks who were doing knowledge engineering, and that's what I thought I would do my research in. But I wound up doing the research more in the social nature of learning, the social psychology part.

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Ledlow: Let's talk a little bit more about that research. Many faculty say, "Yeah this cooperative and active learning stuff seems to interest students, but does it work? Show me the data."

Smith: Lots and lots of faculty have explored these ideas in their classes and . . . the typical measure is that they ask the students what they think and they look at traditional measures of performance on exams and things. And the students often like it, and they like it because it's different and more engaging. There has been quite a lot of systematic work done, mostly Ph.D. theses, and those indicate that students learn more, remember longer, develop better strategies for learning . . . enhanced critical thinking, higher-level reasoning skills. There's more and more [research] now in science, math, engineering, and technology—not as many as in higher education in general—but more and more studies.

And recently there have been some really interesting studies done. A large chemistry class at the University of Wisconsin, for example: two different sections, random assignment of students to sections. One, a pretty much straight lecture format, the other a cooperative learning format. Very little difference in performance on individual exams, which is very common. You have highly motivated, quite talented students; it's hard to find differences on factual exams. But they did a series of personal interviews, where they didn't know which section students were coming from, with very probing questions. And the students who spent their class time explaining these ideas with one another did much better with depth of understanding.

Ledlow: Karl, can you briefly describe the difference between cooperative learning and traditional group work?

Smith: Mostly it's in terms of the structure. Oftentimes in traditional group work students are told to go off and work in a group, meet outside of class, produce a joint product, and then the product gets graded. There isn't much else. Whereas in a formal cooperative group, one: there's careful consideration of "What's the purpose? Why are we asking students to work in groups?" when we make sure that there's clear interdependence—that there's a reason for them to work together, or many reasons for them to work together. Most common [reasons] are challenging tasks, something that one person would have difficulty doing by him or herself. Another is a natural division of labor, where different people do different things that all contribute to the group's work or group's success, creating role interdependence. So in cooperative learning groups, especially the Johnson and Johnson model, there is a lot of structure. Typically we structure things around a set of five basic elements: interdependence, accountability, face-to-face interaction where people are helping one another, a set of teamwork skills, and then processing. But the key, the heart of it, is really the interdependence and accountability. And the accountability piece is often missing, that's what the students say—one person does the work, others share the credit. This creates frustration, and that happens very commonly in traditional groups, unfortunately.

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Ledlow: Is cooperative learning compatible with other sorts of active learning strategies like problem-based learning or case teaching?

Smith: Oh sure, there's a very broad range of practice in the ways these ideas are implemented. For example, there's what's commonly called active learning (although some would say, "Is there passive learning? Does such a thing exist?") but active learning, with a sense they're doing something. These are often in-class exercises, short-term, ad hoc, turn-to-your-neighbor exercises, to try to give the student the chance to work with the material. And then there are more complex kinds of cooperative learning strategies, and that's where problem-based learning, case-based learning typically come in. Those strategies are typically done in a formal group, a fairly carefully structured group, with a challenging problem that comes first that drives much of the learning.

Ledlow: Let's define some terms a little bit, though. Some people talk about informal cooperative learning versus formal cooperative learning, or active learning versus cooperative learning. How do you distinguish those things?

Smith: Again I think there's a broad range of strategies that people use. In the work that we've done, we've divided the practice up into three areas: informal cooperative learning groups, formal cooperative learning groups, and cooperative base groups. It's all part of essentially the same model, and it's sort of a continuum in terms of the complexity. So informal cooperative learning, which is often used in class, typically with pairs, is where students are given just a short time to grapple with a question or a task; there's some sampling of [their answers] typically. And I think that's what's commonly called active learning—some kind of student activity during class time.

At the other extreme, base groups are very long-term groups that exist to help one another be successful study groups. They prepare for exams; they read one another's papers in a peer review in a writing course, for example, or a course where there's a writing component. And then in the middle are the cooperative tasks groups, and again this is the heart of most of the cooperative learning work. These are formal groups, so they're carefully structured, they have challenging tasks to do, typically there are roles that are assigned; but they are all part of the same collection of students working together to accomplish a common task, typically to learn new conceptual material.

Ledlow: Some people use the terms cooperative and collaborative interchangeably. Are they interchangeable or do they refer to different strategies?

Smith: I use the two terms interchangeably; I probably caused part of the problem. They are very similar; they both have interdependence at the heart of the idea. They came from very different traditions. The collaborative learning model came from more of a humanities background. The cooperative learning model came from social interdependence theory—Morton Deutsch. Collaborative learning often is a little less structured—and I think maybe it's more of an ideal—and many cooperative learning practitioners really strive to have their students so confident and so well prepared that

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they can provide a lot of self direction, which is more of a significant part of collaborative learning. Whereas in the cooperative learning model, the interdependence is structured, the accountability is structured; it's very highly monitored, at least initially. But again, many cooperative learning practitioners see that a more collaborative model is an ideal.

Ledlow: Let's talk about preparing your students for cooperative learning. Should you explain to students why it is that you're using cooperative learning? And what do you do when you say, "We're going to be using cooperative learning this semester," and your students respond, "I hate working in groups; I don't want to do this"? How do you prepare for that?

Smith: Good question. . . . It's a tough challenge—do you talk about why are we doing this or how well it works, or do you provide an experience that lets them see it? My preference is to maybe say a little bit; but if what you do doesn't work very early on, all the rationale that you provide is not going to be that compelling. I typically recommend do something small early on that you can then refer to [so] that they see that, "Oh my gosh, if we work together we can actually come up with more ideas, we can come up with better solutions." I think that's more compelling than lots of the research rationale or other forms of rationale that you might provide to the students. Do something that works early on.

Ledlow: Do you have an example of one of those types of activities that might demonstrate to students the benefits of working in a group?

Smith: A common one is to ask them to come up with ideas individually, and so you give them a question or a task and they write down all the ideas that they can come up with individually. And then you make note of how many ideas people came up with. And then you give them a similar task where you ask them to do that in groups of two or three. And then you compare how many ideas and what was the quality of ideas. And then they say, "When we interact with one another, we build on one another's ideas; we come up with more and better ideas."

Another way of getting at it is just to acknowledge that sometimes group work isn't all that effective. They've probably been in situations where it's been a failure essentially. One of my favorites is to look at the figure, that [is obtained] if you plot performance versus the type of group, and then note that sometimes there is a dip—that the group is worse than having people work on their own. And then to note that sometimes, or under some conditions, groups work very well. . . . [Then] ask students "What are the characteristics of the groups that have worked really well?" And then just remind them that this takes a lot of work and it takes careful attention to what makes groups work. So either of those kinds of activities seem to help get over that activation energy barrier.

Ledlow: After you've prepared your students for the idea that they will be working in groups or you've given them a little sample, then, if you're ready to move on to using

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formal cooperative task groups or base groups, how do you go about forming teams? What are some of your criteria?

Smith: Carefully and thoughtfully! Often the worst that one can do is say "I want you to work in groups, go out and find one another." The size varies all over the place, people choose their friends—which is wonderful that the students have friends but often they don't make the best task partners. And so if you don't want to invest a lot of time in learning more about the students and their strengths and weaknesses and skills etc, then random [selection] is seen as fair by many students. It's quick and you get equal-sized groups, so many faculty use random [selection]. Another strategy is to use stratified random [selection], where, if there's some skill or background or experience that you know is going to be helpful, to stratify along that and then distribute those folks around to the various groups.

With base groups, some faculty let students express a preference. They say, "Note anyone that you'd like to work with," and then they'll pair people with one person they like to work with and then randomly assign them to another. So they get one person they want to work with, and then they meet some new people. So there are a whole bunch of ways of forming groups; most of them require learning something about the students. Some faculty use learning styles and then try to make balanced groups around learning styles. The key I think is for the faculty member to take responsibility for forming the groups. Some of the research that has been done on this indicates that the groups that perform the best are ones where there's a common interest—they're really interested in the topic or the project—and they are otherwise heterogeneous.

Ledlow: In my own teaching, I use student writing ability as one of the criteria for forming groups, because they write a lot of papers in my class. In an engineering classroom, what are some examples of skills that you might use to form these stratified random groups that you were talking about?

Smith: A common one that we use is spreadsheet skills. There seems to be quite a range of skills that students have with some of these computer tools, [skill with] spreadsheets for example. So you find the folks who have a pretty sophisticated set of skills and then distribute them around. Not that they then do the work for that group, but they become a resource, and they have a responsibility for helping others learn that skill. In some settings, each member is given a special responsibility to develop some expertise or refine expertise and then they have that responsibility to help the group in that area. So others won't necessarily learn as much about that aspect. Diane Rover at Michigan State uses the expert groups in addition to the design groups. So students are members of two groups at the same time: they are a member of a group that has some special responsibility, and they learn a great deal about that, and then they're the member of an overall design group that has members of several of these [expert] groups.

Ledlow: How long should these various types of groups and teams stay together?

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Smith: Well the informal [groups], usually just for a class period. They're typically formed on the spot, and they don't meet outside of class. For formal teams, I think it depends. Some faculty leave them together all semester. They form them very carefully, and they work with helping them be successful, and they leave them together all semester. If you do that, you have to invest some care and attention to making sure they work fairly well. Other faculty, like me, change groups occasionally—every three or four weeks, reassign the groups. It gives students a chance to meet someone new and to practice their forming skills of getting up to speed with the new groups. It also helps address those groups that aren't working so well. And not all these groups work equally well. Some of them work wonderfully well and, of course, they don't want to change. Others struggle, so if you give them a chance to change, it's often a relief for them.

Ledlow: You said that if faculty are going to use teams that are going to stay together for a good length of time, they have to invest something in helping those teams become fully functioning. How do you do that? Can you talk a little bit about teambuilding and how and why it's done?

Smith: I think there are things that need to be done at the beginning, and then there need to be regular opportunities for reflection and processing on how well the team is going. And maybe even problem solving and maybe even some counseling. Early on, I think it's important to do something to help people get to know one another. There are lots and lots of teambuilding activities that are available, and if you have the time and are willing, I think they probably work just fine. Many engineering faculty, though, see it as taking time away from engineering content or engineering material. So what I suggest is finding these teambuilding activities that actually have some academic or engineering content and then using those to help people get to know one another. Colleagues here at Arizona State, in a freshmen course, call this personal before professional: helping people get to know one another before you give them these challenging tasks that really demand that they work well together.

So once you've gotten a group of people familiar with one another and you've got them working with one another, the work doesn't stop. Because then you need to periodically provide a time and opportunity for them to examine how well they're working. One of the simplest ways of doing this is the plus-delta, commonly attributed to Boeing. It asks students to think about what's going well in groups, what are you doing well (that's the "plus"), and then what needs improvement (that's the "delta"). And some faculty collect those and look at them to try get a sense of how well the groups are working. Also, faculty need to be paying attention. As students are working in groups, this is not a time to have coffee and grade papers; this is the time to be out there paying attention, monitoring, checking for understanding of both the academic material and how well are these groups working. And that's an important piece of a lot of the faculty development and training: helping faculty figure out what to look for, what to listen for, and how to get a sense of how well these groups are working.

Ledlow: That brings me to another point. Faculty have said to me, "Your background is in psychology; this human relations stuff is part of your content. What about me? I'm

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teaching calculus, or I'm teaching chemistry, or I'm teaching freshman engineering. What do I know about group dynamics? Should this be my job?" How do you respond to that?

Smith: It's not what we were prepared to do, at least not faculty of my generation. The current generation of faculty actually are prepared to do some of this stuff. More and more, beginning faculty have had time and opportunities to think about teaching and learning. Yes, it's challenging, but given what we know about how people learn, the importance of explaining with one another, that helps many, many students—actually many faculty say, "You know I really never understood that as well as when I taught it." Well, that's the idea: we're trying to get the students do some of the explaining. And faculty do this to a greater or lesser degree; some are quite comfortable with it, quite good at it, but I think all faculty can do some of it. And the other piece is that, if you look at how engineers work in the world, most engineering is done in teams. So, I think we have some responsibility to help our students learn how to work with one another as well as how to work on their own.

Ledlow: Let's get into lesson design, or getting started making actual content lessons. Your students have bought into the idea that they'll be working in teams, you've formed the teams, and you've done some teambuilding. Now it's time to actually do the tasks. What sorts of tasks are appropriate for cooperative learning versus individual learning?

Smith: Actually the design needs to come before all of that; you really need to be thinking about the design over the entire course, or at least module or exercise. The key in the design area and in choosing tasks is to remember that almost anything can be redesigned to be done in a cooperative format. But, it's important to have variety. Not everybody learns in the same way, different people appreciate different kinds of things, and so [make] sure that you orchestrate some variety. And then, in the design of the cooperative learning experiences, [think] about what's the objective: what is it that I want students to know, to be able to do; what procedures do I want them to be familiar with? And then we would add a second type of objective: what kind of teamwork skills would I like . . . to emphasize in this cooperative lesson or experience? So like all good instruction, you have to start with a sense of purpose: what is it that we want students to be able to do? This is getting easier now with ABET because of the outcomes—the ABET Engineering Criteria 2000, where we're being asked to look at what is it that graduates are able to do.

Then the next piece is making sure you really clearly structure the accountability and interdependence. Those are the key aspects, and they really need to be designed into the experience. I'm kind of skirting around your question to address what kinds of tasks. I think that the more complex the material, the more dense it is, the more challenging it is, the more helpful it is for students to have other students to work with to master the material. More routine tasks, simpler tasks—probably it's better to let students work on them on their own. But when it's really complex and it's really demanding, then you probably want to think about having students work in groups.

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Ledlow: For faculty who are just getting started using cooperative learning, what are the advantages of using some pre-designed cooperative learning strategies like Think-Pair-Share, Jigsaw, Academic Controversy, Formulate-Share-Listen-Create? You've developed some of these strategies; is that good place for faculty to start?

Smith: Actually, we resisted developing those kinds [of] strategies, because we wanted faculty to understand the basic concepts and then operationalize them in ways that made sense to them. It seems that many, many faculty need some help—some models, some examples to get started. There are lots and lots of wonderful examples, and they seem to make it easier for faculty to get started because they are very well worked out. All these structured decisions have pretty well been made, the procedures are very carefully documented; and so it helps faculty to get started. What I hope is that faculty then make these their own [strategies] by modifying [these] in ways that makes sense to them and that work for their students. But [pre-designed strategies] seem to be a wonderful bridge for many faculty to get started. It still doesn't make it any easier to stop talking and give something to do, but it at least lays things out for faculty to see that there really is a plan here, and it has a chance of working.

Ledlow: I want to follow up on the idea of structure, because I started out, not with the Johnsons' model as you did, but with Spencer Kagan's Structural Approach and moved, largely as a result of your influence, into an approach that incorporates a lot more of the Johnsons' thinking. We had this conversation once a few years ago and I'd like to revisit it—the question of how much do you structure within the lesson. I think the Johnsons would have you give the students your academic objective, their team skills objectives, and the leave the "how" they accomplish the task [as] something that they work out [themselves]. . . . I tend to more strictly formulate or give a recipe for how I want students to go through and solve a task. Perhaps I ask them to first individually brainstorm, then compare, then come to consensus, etc. And I think your approach is more to resist that type of thing. Can we talk more about that?

Smith: Probably we resisted it more 15 years ago. My sense is the conceptual approach that the Johnsons developed and the structural approach that Spencer Kagan developed are really coming closer together. Kagan talks more about basic elements, simultaneous interaction, positive interdependence—the skills that are needed; and the Johnsons' model has adopted or adapted more and more of the structures approach. And I think that faculty need both. They need a good conceptual foundation, but the theory without a set of models, without practices, is just too hard for many faculty for whom this isn't their main line of work. It's too hard for them to implement. One of the dangers with a purely structural approach, without having some grounding in the underlying theory, is if something goes wrong, you don't have a way of diagnosing it, of figuring out, "Why didn't this work the way that I thought it should?" Just as we wouldn't ask engineering students to just plug in formulas or do some expression without having some understanding of the underlying theory—but also we use these computer tools and short-cut approaches and procedures. But it's both; we really need both—the structures and the conceptual framework.

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Ledlow: I agree. I like the idea of the structures . . . they also remind me of what's going on in the rest of my professional life, in terms of—if we're going to a meeting, no one would think any more of not having an agenda, or not, perhaps, having decision-making tools available. So we want some sort of balance between giving people tools with which to complete tasks, and having some flexibility about how we might proceed.

So how do you design a task? You're in your class and tomorrow you want your students to tackle problems cooperatively. How do you go about planning or designing that lesson? What are some of the things that you consider in terms of getting students prepared, giving them instructions or advice or guidelines?

Smith: I think . . . starting with shorter-term exercises earlier on—individual reflection followed by pair work—to get them familiar with the idea of working with one another and then building to more complex kinds of tasks.

What we typically recommend is just looking to see what's already available, because the folks who have been doing the problem-based learning in freshman physics, chemistry, biology have wonderful sets of problems and tasks. So rather than inventing all of this stuff yourself (which I think is wonderful if faculty have time to do it), for many faculty it's easier to redesign something or to adapt something that others have created. We did a book a few years ago called How to Model It, which is a problem-based type approach; each chapter starts with a question or a task, asks the students to do something, and then we work with what the students do. We try to ask them questions about it; we try to get them to build a better understanding. I think many of these formal cooperative learning activities work in this way—there's some kind of a complex, slightly open-ended problem or task, or there's a complex text that students have to make sense of, and they work on it together. It's carefully monitored by faculty, with these regular interventions, or set of procedures, to keep on top of what students are doing.

Ledlow: How does the assignment of roles enhance students' work in groups? Do you always use roles?

Smith: There are a few roles I think are always needed—recorder, for example. If it's cooperative group work then that means they're doing something together that needs to be documented, and so randomly assigning a recorder and rotating [the assignment], I think, is really an important role. And if you don't want to invest a lot of time and effort, it's probably the most common role.

Another role that I like is called the process recorder, the person whose job it is to pay attention to how well is this group working, "Does everybody participate? What happens when somebody says something? How does the group make decisions? What happens if there's disagreement? How does the group deal with conflict? Do they talk about strategies? Do they stop and meta-process?" That's part of becoming an effective team member: paying attention not only to are we accomplishing the task, but how well are we working with one another. The place that other roles enter in here is when you think about what do teams need to be successful. Often they need

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someone who's generating ideas. They need someone who's disagreeing constructively. They need someone who's probing for a real depth of understanding. They need checking—checking of the math, checking of the conceptual understanding—and often we can assign those as roles, and they contribute to the effectiveness of the groups. Elizabeth Cohen would advocate that roles can provide status. If you have folks who are shy or quiet, giving them a role gives them a responsibility, gives them status in the group. She calls these "status treatments" and they're a way of getting better participation and really getting the best [out] of individuals who are in the teams.

Ledlow: How do you feel about assigning the role of team leader? I know I don't do it in my own teaching.

Smith: Good for you!

Ledlow: I guess that means you agree.

Smith: Groups need leadership; without leadership they flounder. But for novice groups, having an assigned leader often means that person gets stuck with a lot of the work. So there are groups that have a leader that does much of the work and a whole bunch of followers who are happy to let the leader do the work. So the approach that we use, which sounds like a similar one to what you use, is called a distributed actions approach to leadership, and it often ties into the roles. So you look at, "What do these groups need to succeed in accomplishing the task and in getting better with working with one another?" And so the leadership roles are often assigned around these task and maintenance behaviors. And if you think about effective groups, effective groups get the job done—they produce the report, they learn the material, they finish the procedure and they get better with working with one another. And lots of our students do the first—they get the job done; but sometimes they hate one another so intensely at the end of it that they will never want to see one another again—and that's not an effective group. Similarly, groups that have a great time, where they enjoy one another's company, they get along really well, but they don't finish the project. That's not a successful group. Successful groups do both things: they get the job done, they get better at working with one another. And that takes careful consideration on some of these roles and an emphasis on the process.

Ledlow: Could you give us some tips for ensuring individual accountability in teamwork? I know you mentioned that the interdependence has to be there, but hand-in-hand with the interdependence we have to be able to know that one of our students didn't do all of the work, or one of our students didn't do none of the work. How do you build in individual accountability when you're designing lessons and activities?

Smith: It's very important because it's essential to remember that the emphasis is on the individual—it's helping individuals learn more, remember it longer, develop more skills and confidence to learn how to succeed in these environments. But we're trying to get at that through having them work with one another . . . some faculty, and I know

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students, feel there's neglect here in terms of the accountability. The traditional measures are probably best—individual exams, individual quizzes, individual writing assignments. So you have students working together, help one another learn this material. Then [they] have to be able to do it [themselves]. . . . [Another way is] monitoring. One of my favorites is a strategy I learned from Allen Shoenfeld, a mathematician, who listens in on groups as they're working with one another. He will stop by a group and ask, "Has your group agreed on an approach for this problem?" He says often one person will say "yes." Then he asks someone else, "Would you please explain the method that your group is using on this problem?" That's called individual oral exam. It's a way of monitoring groups and checking for accountability. And it does some really interesting things, in that sometimes that person gives a very articulate response; other times they say, "I'm lost; I don't know!" Then you need to turn back to the group and do some processing with them. Other favorites, and I know lots of faculty use these, are randomly calling on students . . . using either a random number generator or I ask each student to put his or her name on an index card and I have people draw cards out of the pile. Some students get nervous about that, but that's the idea with accountability—it's that you're responsible. Strategies like that, even though they may make students a little nervous, are seen as fair because it could be anyone. I'm not picking on people. And then you can sample them in a variety of ways: you could put the cards back in or not, or sample with or without replacement; and it seems to be an affective way of ensuring accountability.

Ledlow: Those are great ideas for inside the classroom, but what about the senior design project where most of the team's work has been taking place outside of the class over the course of the semester? What are some ways that you can get a feel for what's been going on in the team?

Smith: Meeting with individual teams on occasion, interviewing team members, collecting processing information, asking them what's going well, "What are you doing well, what's not going so well, what's helping you, what's interfering?" and then getting a sense from the different teams where there may be problems. And again, I think you just have to monitor and collect this kind of information. Also, if you notice that there are problems, or students come to you and say, "My team is not working," or "I'm doing all the work," then that often can get turned around in a problem-solving session. Take fifteen to twenty minutes and say, "I understand that there're some problems occurring on this team. Take a moment and jot down what's interfering with your progress, what's causing you problems." Then I often have students put [the problems] on a flip chart or on the board. It's quite interesting because the problems are common across teams. So students are seeing, "I'm not the only one; there are others of us having problems." And the problems are: people don't show up, they don't come prepared, they dominate, they want to do it all, they don't want to let others do anything. And once you get those problems out on the table and start grappling with them, they figure out how to solve them. But again, it takes some attention and it takes a procedure for identifying them and then dealing with them.

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Ledlow: Do you do some of this troubleshooting with individual teams outside of class? If a student comes to you and says, "I'm just miserable and this is going terribly," and that doesn't seem to be typical of what's going on in the rest of the class, in what ways are you willing to become involved in mediating that conflict?

Smith: In those rare events (and actually they are fairly rare, but they're memorable), if a student comes to me and says "my team is not working" or "I'm doing all the work," I usually ask, "How have you addressed this in your team?" They look at me strangely and say "You formed this team, this is your problem. Why are you asking me what I've done with it?" And so then I try to take them through a way of going back and trying to get the issue out on the table. If that doesn't work, or if they're reluctant, then on occasion I will meet with the team or have a TA meet with the team in a problem-solving type session where we try to help them get a sense of what problems are occurring on the team and what they can do to deal with it. It's interesting, because it's often the person who comes and says the rest of the team is the problem, that person is often the problem. When you monitor that and ask "How do you see it?" and "How do you see it?" and "How do you see it?" it's often a quite interesting event.

Ledlow: I've had that experience as well, where the person who sees himself as having tremendous leadership skills is seen by teammates as being overbearing.

Smith: You haven't raised the issue of peer review yet.

Ledlow: No, no I haven't, but let's go to that.

Smith: I was hoping you'd avoid it, but I know you mention that a lot of engineering faculty do it. I think it has to be used with real care. It takes a lot of preparation. It's something that I think can either be a waste of time where everybody treats one another as above average—where there's a kind of collusion: "Let's be nice, let's not disagree." Or it can turn fairly destructive where students are rating others low just so that they look better. It's a little safer to do individual review: "How well are you doing? Rate yourself on a scale from one to ten along a variety of criteria." And then . . . how well is the group doing, but not other individuals. At least initially, that's a way of getting at trying to collect some data on how well the team is functioning. It starts building up individual reflection skills: "What about me? How well am I contributing? Am I participating? Am I providing the needed leadership? Am I coming prepared?" And then, "How well are we doing?" That often helps groups identify problems without having to name individuals or identifying individuals—it's "We have some problems as a group. Some of us are doing more than others and we need to deal with that." It's maintaining the emphasis on the "we."

Ledlow: Some faculty use these peer assessments in grading. I've struggled with that. I haven't found a way that feels fair and accurate to turn peer assessments into grades. Do you have any advice for me?

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Smith: Grading is one of the great challenges, no question, and I think it's a faculty responsibility. I think the faculty should be making the decisions about individual student's grades based on individual student work and/or on joint work. Many engineering faculty have students work together to produce a joint product and then the product gets a grade, but it will probably be five, ten, fifteen percent of an individual student's overall grade. Most of the grade is based on individual work. Mixing in the peer assessment, unless it's done extraordinarily carefully, with quite mature groups, has more problems than it's worth.

Ledlow: So maybe I'll stick with not doing it.

Smith: Until you and the students are ready. It's done in the work world, so somewhere our students need to have experience with it and get a sense of how it works and where it might be appropriate to use it. But it can be misused so easily. And it can really create a lot of competition within groups and break down the cooperative relationships.

Ledlow: Let's talk more generally about grading now. Group grading is one of the more controversial topics in cooperative learning. What's a good balance, how do you arrive at that, how do you decide how much of a grade should be cooperative versus individual?

Smith: First and foremost I think we need to dispel the myth that cooperative learning means giving a group grade. And some faculty who say "I use cooperative learning" are only giving a group grade and that's causing lots and lots of problems in terms of fairness, in terms of what individuals bring—individual skills, background, experience, motivation. Not everybody perhaps is willing to work for an "A" in the course; some may be working full time or have other kinds of responsibilities and they're hoping to get a "C." And to have a large portion of [the grade] based on a group grade probably is unfair and causes lots of problems. It's probably better, I think, rather than using the single-product/shared-grade interdependence as the centerpiece, is to use what's called learning goal interdependence. It's a form of goal interdependence, but it's about helping each student learn. The way it works is when a group has a learning goal, they're not finished until each person understands and can explain at least a reasonable portion of the material. It has a similar effect of producing a common product, with a shared grade, but it ties in much more effectively with the accountability, because [they know], "Our job is to help each of us learn and then perform on an individual exam or an individual written assignment." It's much more coherent, rather than only producing a group product. Our students need to experience working together to produce a group product—it's common in the world. We just do one design, we do one product, although now we do more and more prototyping. So they need to learn how to do it, but I don't think it should be a prevalent part, especially in more content-oriented courses.

Ledlow: In my experience, when I have students do informal team problem solving in class, they're far more motivated to do that than to listen to me lecture. Yet still some faculty say to me, "I would have to grade those things, because otherwise my students

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just wouldn't do them." That hasn't been my experience. What is your experience in terms of grading informal cooperative learning activities in class?

Smith: It hasn't been my experience either. My classes typically have eighty to 100 students, so if I collect [the work], I have to grade it—more work than I want to cope with. I think as long as it's an interesting and meaningful and challenging task that they are curious about, then they will do it. Not everybody does it and that's what I think some faculty notice. They do an informal cooperative learning activity and not everybody does it and they attend to the ones who don't do it. I know some of my colleagues . . . are quite jaded [and] think "If we don't grade it, they won't do it," so they grade everything that they ask the [students] to do. It's a lot of grading!

I think if you feel you need to do that, there are simple things that one could do. You could use a binary grading system for example. If they do it, and they do some responsible, conscientious [work], they get credit. If they don't do it, or if they don't put in much effort, they don't get credit. So you can save yourself time on grading. But I think we need to move beyond using only these extrinsic motivators and try to recover and build more intrinsic motivation. Try to recapture and re-embrace students with that curiosity that young children have and get them to go beyond just "What am I going to get for this?"

Ledlow: Let's talk about classroom management now. Many faculty ask me "What am I supposed to be doing while my students are working in teams?" You've mentioned floating around and observing, but could you talk a little more explicitly about what you're doing while you're observing your students?

Smith: Sure. In the more formal cooperative learning models, the idea is that you carefully set things up and you try to move the locus more to the students, so they're working with one another. Some faculty do leave [the room], though that's more common in a collaborative learning model; but that shifts a lot of the responsibility onto the students. So in most of the cooperative learning models, faculty are present. They may distance themselves a little bit at the beginning, but they don't go off and grade papers or have coffee. They're still there paying attention, and then most faculty wander around to listen in; and of course you need to do this fairly carefully because you can be intimidating. Often when you stop by a group early on, they'll all stop talking and look at you and wait for you to say something, and you need to try to turn it back to the group or move on if it's making them nervous. Your presence wandering around—I'm sure you've experienced this, Susan—[gets them] back on task, or you see them asking really insightful questions as you wander by. They go through that phase . . . where our presence seems to raise their level of responsibility, but eventually they don't notice that the faculty member is there and that's what I'm looking for. They're comfortable with the process, they're engaged with the material and one another, and they don't notice what's going on around them. It's interesting that some faculty say "Oh I don't think this will work for me; I would be too distracted by these other conversations." And yet if you ask students, "What about the other conversations that were going on, were you distracted by them," a few students say "Yeah, I noticed and it

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was a little disruptive." Most students say "I was so focused with what was going on here in this small group, I didn't even notice."

Ledlow: If you come up to a team, and they're trying to solve a complex problem, and they're way off base, do you intervene?

Smith: Probably not. I try to follow Roger Johnson's advice and here Roger says if you think you need to intervene, don't—unless it's something criminal or if it's just unacceptable. If they're a bit off task, you may want to make a note of it and move on. Give them a chance to identify that they're having difficulty and give them a chance to try to get back on track. If it's just unbearable for you, then Roger would recommend intervening with a question. Stop the group, intervene, ask them a question. Don't assume, in other words. Ask them what's going on, and then try to facilitate. Once you've helped to get them back on track, then move on.

Ledlow: At the end of a class where you've had students working in teams, how do you pull it all together? I think many of us, when we started, were so enthralled by the idea that students are responsible for their own learning we kind of let them go. Now, I'm really conscientious about debriefing. What's your take on that?

Smith: I think that some whole-class processing at the end [is beneficial], in terms of, "What are the key ideas, what do you need to do next? What are some of the questions and concerns?" (the kinds of things that Cross and Angelo have helped us learn through things like Minute Papers, or individual reflection, or group reflection). "What are the key insights you gained today? What are some additional applications?" I think that helps bring the class back together. You need to provide a sense of closure for the class period. Sometimes it's done by written pieces within the groups, but sometimes by the whole class. I think, again, it's a way of trying to pull things together, bring some closure, get a sense [of], are there difficulties that need to be reexamined during the next class period and get a sense of how well it's going.

Ledlow: If a faculty member came to you and said "I hear you're a big shot in this cooperative learning stuff and I'm thinking about trying it," what advice would you give them?

Smith: Lots and lots of faculty said "I'd really like to figure out how to do this." First and foremost I would recommend, find or form your own team. Find some other faculty who are interested in doing this, and are willing to do it and try out the ideas with one another, create a plan with one another. When faculty work together it models the cooperative learning process and I think it helps build enthusiasm, morale. They get better ideas and then they're likely to put the reins on and help faculty resist launching [cooperative learning] all at once. And there've been so many examples of faculty who come to a workshop or come to a seminar, get all excited and say "I'm going to drop what I was doing and I'm just going to do this." And if often fails miserably. Not always, but it often fails miserably. So beyond that, I would suggest, start early; start small; build; pay attention to the students; collect information from them about what's going

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well, what's not going so well, what's helping them learn. And of all those suggestions, I think the one about starting early is probably the most important.

Ledlow: Could you say a little more about that or give an example of how you do that?

Smith: One of my favorites is a comment from Parker Palmer who says, if we want to change the ways that students meet and interact, if we want to change the expectations, we need to do something within the first few minutes of the first class that says, "During this class, you're going to work in a variety of ways. Sometimes you're going to listen to me, sometimes you're going to work individually, sometimes you're going to work with other students." One simple thing that I do in workshops and in my classes is within the first couple of minutes I say "We're going to do some cooperative work in this class. Would you please take a moment and turn to the person next to you, introduce yourself, welcome him or her to this class." That does a bunch of things: it gets them talking with one another, it surprises them because, unfortunately, in Minnesota it's the first time they've had a chance to talk with another student during the first class period, except maybe out-of-turn. It creates that expectation that "We're going to do more that listen to the professor in this course," and it makes it much easier to do other things later on.

Ledlow: When teamwork works well, what are the benefits?

Smith: The benefits are students have more fun. They work harder, but they really don't feel like they're working hard because they're enjoying it. And if you ask students "How do you learn best?" many, many students will say "I learn best when it's something I'm interested in learning, where I'm motivated to learn it or when I see a need to learn it." And it's often this working with other students where you get this peer support, the peer pressure; it just makes learning more enjoyable.

So when it's working well, you see a lot of synergy; you see a lot of building on one another's ideas so that they come up with more and better ideas. You see a lot of respectful disagreement. There's another myth that cooperative groups are places where everybody's nice and there's no disagreement. Those are terrible experiences typically, because in cooperative groups there's often a high level of controversy—but it's respectful disagreement. It's disagreement about trying to come up with a better way to solve a problem, a better way to make a decision, a better understanding of complex material. And so respectful disagreement is central to high-level performance in groups.

Ledlow: How do students react to cooperative learning?

Smith: Often with some surprise, at least early on. They're becoming more accustomed. In some settings, actually, we're probably asking students to work in teams too much. I remember meeting with a group of students a year or so ago at Michigan State and the students were saying "We're in four different base groups, we're in five formal teams, and it's overwhelming for us." And the message from that was,

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faculty need to get together and put them in one base group. And so I think we need to pay attention to what students have to say. And I've been collecting data on what students have to say about [cooperative learning] and what they think about it for years. One of the most memorable comments was a student who said "This group work is really hard, but please keep it up."

Ledlow: That's wonderful. Karl, thank you so much.

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