In a perfect world professors would have the time to get to know every one of their students as individuals and would be able to tutor them when they had difficulties. Although this is seldom feasible, professors do have significant one-to-one contact with students. One-to-one contact occurs when a student asks a question and the professor makes eye contact while answering the question. It also occurs when a student asks a question after class or in the hall, and when a student comes to the professor’s office to ask questions. Although brief, these encounters have a considerable impact on rapport with students; thus one-to-one contact has a major effect on the professor’s effectiveness as a teacher. One-on-one contact can also have very significant impact on students. Most of our rewarding student interactions have occurred because of one-to-one interactions. See Wankat and Oreovicz (1999) for real examples, but with the names changed.

Advising and counseling usually involve significant one-to-one contact. Many professors have the most contact with individual students serving as research advisers for graduate students.

The one ability common to all these examples is skill in listening. Actively listening and responding is a necessary skill for excellent one-to-one teaching and advising. Unfortunately, this ability is often neglected. Listening skills will be discussed first, and then particular one-to-one teaching and advising situations will be considered.

10.1. SUMMARY AND OBJECTIVES

After reading this chapter, you should be able to:

- Explain and use methods to improve listening.
- Improve tutoring of students and become more effective in helping them learn.
- Improve both academic and personal advising skills.
- Outline your personal value structure for advising research students, and then develop procedures to improve your advising of these individuals.
10.2. LISTENING SKILLS

“You can hear a lot just by listening.”
—Yogi Berra

Everyone who writes about listening laments the lack of skill in this important communication area. However, learning to listen can be very difficult for professors since many of us really do like to talk. Listening skills are also critical for effective advising and tutoring. If one of the goals of your department is to improve the communication skills of the engineering graduates, then it may be appropriate to teach students to improve their listening skills. Listening exercises can easily be incorporated into laboratory and design courses.

Listening is a skill that can be learned, but practice is required. Listening skills are discussed in many counseling books (e.g., Edwards, 1979; Egan, 2010; Hackney and Cormier, 2012), in many books on teaching (e.g., Eble, 1988; Lowman, 1995; Svinicki and McKeachie, 2014; Wankat, 2002), and in engineering education articles (e.g., Katz, 1986; Wankat, 1979; 1980). Reading about listening skills can be a first step, but significant improvement requires practice.

10.2.1. Setting the Climate

First create a climate that allows listening to occur. To become known as someone who listens, you must be available, and the easiest time to be available for the largest number of students is before and after class. Students must come to class anyway, so the barrier to talking to the professor is significantly less than in coming to an office. Come to class five or ten minutes early. This gives you a chance to make sure that the room is ready for class, but it also sends a subtle message that you are interested and looking forward to the class. It gives students a chance to talk to you. Early in the semester it is useful to walk around the room with a class list, talking to students and learning their names. Later in the semester students will come up to you to talk. Students often have questions after a class; by staying a few minutes you can further develop a rapport with them. You may have to avoid scheduling a meeting immediately following the class. If the after-class period is too rushed, you might consider finishing class five minutes early. Since you don’t want to delay the start of the next class, it helps to be available for short questions outside the classroom. Office hours are useful for longer discussions and for dealing with private concerns of students (see Section 10.3).

Professors and students are not equal—in knowledge, experience, or power. These inequalities in power and status inhibit some students (nothing inhibits other students!). Facilitate student interaction by making the environment more equal. Reduce barriers: Step from behind the podium and take a few steps toward the students. Wander in the audience to solicit interactions with students. Be relaxed and nonverbally encourage students to talk. Sitting down on the edge of a table or desk indicates that you are relaxed and have time to talk. Rearrange your office so that the desk is not a barrier between you and the students. [If you are new to academe and feel a bit insecure, you might want to have the desk between you and the students. Look into proxemics (Hall, 1966) for more on the role of space in nonverbal communication. Also see Section 10.2.3 below.]

Attitude is important. Generally speaking, people who are classified as feeling types on the Myers-Briggs Type Indicator (see Chapter 13) will have an easier time conveying to the students the impression that they want to listen. Thinking types need to consciously think about the students’ feelings. Perceptives tend to enjoy the uncontrolled give-and-take of discussions with stu-
students, while judging types need to schedule this time. By knowing yourself, you can adjust to be available and to listen to students. A note of caution: If you don’t particularly like students but love the content, don’t try to fake being the students’ friend. They will see through your facade. Aloof professors who are content experts can be good teachers (see Table 1-5).

To encourage interaction with students, be nonjudgmental: There are no “dumb” questions. There are questions that show a lack of understanding, and there are questions you don’t understand. The purpose of listening is to clarify your understanding of the questions so that you can help students understand the material. It is also helpful to avoid being defensive. This can be difficult when students are angry and are attacking a test, and may be attacking you. Although there are no dumb questions, there are hostile ones. Sometimes acknowledging a student’s feelings (see Section 10.2.2) will calm her or him so that he or she can listen to facts. Sometimes humor is useful in deflecting the hostility. If no progress is made, offer to talk to the student privately after class. Discipline problems are discussed in detail in Chapter 12.

Being nonjudgmental does not mean “anything goes” or that there are no standards. Instead, it means that actions and behaviors are evaluated, not the inherent worth of the student. There are times “when a student is rationalizing about the difficulties and needs to be told bluntly to make an attitude adjustment and work harder (or more efficiently)” (Herrick and Giordano, 1991). When being blunt with a student, tell the probable consequence of actions or inactions, but without a character analysis.

10.2.2. Focus

Your first focus should be on the student. Make eye contact, move or lean toward him or her, offering nonverbal encouragement. Listen to what the student says completely without trying to formulate your response before he or she is finished. Use your brain’s “free time” to ask yourself questions about what the student is trying to say. What is the underlying message that may be hidden in the student’s response (Katz, 1986)? A useful technique is to paraphrase the question briefly after the student is finished. This ensures that you have understood it, and in a classroom situation ensures that everyone has heard the question. Repeating the question also gives you a little more time to formulate an answer to the question.

The best atmosphere for a class is one where the professor is there to help the students master the objectives. Unfortunately, in many classes the professor is the enemy. Anything that you can do through one-to-one contact to help students feel that you are there to help them learn helps improve the atmosphere in the classroom. How much of the student’s problem should be solved by the professor and how much by the student is a judgment decision discussed in Section 10.3. Another trick for focusing on a speaker’s message is to take notes. This may help you listen and pay attention at faculty and committee meetings, seminars, after-dinner speeches, and so forth. It is also appropriate to encourage both undergraduate and graduate students to take notes in meetings with you.

There should also be some focus on emotions. Emotions are always present, and if not dealt with directly may prevent communication and learning. This is particularly appropriate in private, but can also be appropriate in a classroom. In class, it is usually sufficient to acknowledge the emotion and then move to the content of the question. For example, “This appears to be an emotional issue for you. Let’s look at it from another angle;” or, “I see that you are upset about the grading of this test. Let me answer the question now and then we can discuss the grading
after class.” In private, spend more time exploring the student’s emotions (see Section 10.4).

Although it is appropriate to focus on the student’s emotions, it is usually not appropriate to focus on your emotions as the professor. Try to remain rational and nondefensive. This is particularly true in class where an emotional outburst can do significant damage to your standing and credibility. Unwind later by talking to a friend privately.

10.2.3. Responses

Individuals make nonverbal, minimally verbal, and verbal responses to others. An additional response is silence. All these responses should be congruent. Students receive a confusing mixed message if your words do not agree with the nonverbal signals. This is one reason why most people cannot fake interest or caring for long periods.

Nonverbal messages include facial expressions, eye contact or lack of eye contact, interpersonal distance, hand gestures, and body language (Axtell, 1991; Goleman, 1995; Navarro and Karlins, 2008). In Western cultures direct eye contact with occasional breaking and reforming of the contact is expected. Leaning forward is usually interpreted as a sign of interest, as are nods and encouraging hand gestures. An open stance or sitting position is interpreted as signifying openness, whereas crossing one’s arms suggests a closed, defensive position. Clenched fists are often interpreted as anger, as are angry facial expressions. These are powerful signals which most individuals raised in a Western culture transmit and receive unconsciously (Axtell, 1991; Navarro and Karlins, 2008). The signals are often so powerful that words are ignored if they are incongruent with the message.

An individual can change the nonverbal messages he or she is sending. Changing behavior often changes the individual’s feelings. If you find that you have your arms tightly crossed and you are resisting listening to a message at a meeting, purposely opening your arms and relaxing will probably result in better listening. Since changing behavior often changes underlying emotions, it is useful to monitor and change the nonverbal clues you are sending to your students (see Section 3.3.9). One problem with nonverbal messages is that they may be misinterpreted. For example, the tightly crossed arms in the previous example may simply mean that the person is cold, while it is interpreted as being closed to an idea. In addition, the nonverbal messages of different societies are different (Axtell, 1991). In India shaking one’s head from side to side signifies agreement, not disagreement as it does in Western society. The appropriate degree of eye contact and comfortable interpersonal differences are very different in different societies. If you are listening to one of your students and the nonverbal and verbal messages appear to be incongruent, it may be that you are misinterpreting her or his nonverbal messages. And he or she may be misinterpreting your nonverbal messages.

Minimal verbal messages are sounds like “uh” and “uh-huh” and words like “oh,” “yeah,” and “OK” that do not convey meaning but encourage the person to keep talking. Minimal verbal messages sent by the listener imply that he or she is paying attention and understands the speaker. These messages are often used in private conversation, although they are also appropriate when a student is talking in class. If speakers often act as if they don’t know whether you are listening, you may need to increase your use of minimal verbal messages. However, faking minimal verbal messages when you aren’t listening will get you into trouble.

Verbal messages are an important part of the active listening process. Probes are questions or directives which ask the speaker to tell more. Probes can be nonspecific, “Elaborate on
that” or “Tell me more;” or quite specific, “What would one observe if the weld was bad?” or “You are confused about the application of Kirchhoff’s laws in this situation.” Probes are often more effective if they are open-ended questions or directives which cannot be answered with a simple yes or no response. If you ask closed-ended questions and get yes or no responses, then change the questions to make them open-ended.

Paraphrasing what the student has said in your own words is useful for letting him or her know that you understand. It is appropriate to ask if your interpretation is correct. Summarizing long statements in both classroom and private discussions is another useful active listening technique: “What I heard you say is . . .” Again, it is important to check with the speaker that the summary is correct.

Silence is not golden if it does not encourage communication or becomes threatening. Use silence to encourage communication, not to punish students. Professors usually do not pause long enough after asking questions. A period of silence is necessary to allow students time to respond. In class this will be less threatening if you do something useful during the period of silence. For example, ask a question, clean off the board, and then turn back to the students for an answer. Silence, perhaps punctuated with a nonverbal response, is also appropriate when a student is clearly processing information and is not ready for more communication.

Silence is very useful when students are trying to manipulate you. A common ploy is for a student to tell all the reasons why he or she will have trouble handing in an assignment on time or taking a test when it is scheduled, but never make a direct request for postponement. Since no request has been made and no question has been asked, there is no need to respond. Silence is an effective counter ploy since it forces the student to be honest about the request. An alternative response is to use a probe such as “Well, what are you going to do about it?” There is a final use for silence. When a student breaks down and starts crying in your office (yes, this does happen), one appropriate response is to offer a tissue and be silent until he or she has regained control. Always have tissue available in your office.

10.2.4. Comparison between Listening and Nonlistening Behavior

Table 10-1 presents a comparison of listening and non-listening behavior that can serve as a checklist for monitoring your behavior or for helping students improve their listening skills.

10.3. TUTORING AND HELPING STUDENTS

We use an inclusive definition of tutoring to include helping students before and after class, during office hours, in special help sessions, in the halls and on the telephone. We rejected the idea of calling this section “Office Hours” since only a fraction of the students in a class come to see a professor during office hours. A majority of students can receive individual attention and at least minimal amounts of tutoring when the professor broadens availability.

We are interested in improving tutoring because experienced human tutors can increase a student’s score by approximately two standard deviations (commonly called sigma in this literature) compared to classroom instruction (Bloom, 1984; Zemke and Elger, 2008). Two sigma means an average student can be in the top 2% of the class. Zemke and Elger (2008) note that two sigma is a generalization and measured improvement ranges from 0.4 to 2.3
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sigma or there may be no improvement in learning. Cohen et al. (1982) found a 0.4 sigma improvement (approximately half a letter grade) from untrained tutors. The large variation indicates that significant improvement is possible.

### 10.3.1. Tutoring Locations

Right before and right after class are the most efficient times for tutoring because many students ask questions then but are not tempted to visit with the professor. Coming to class early

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**Table 10-1. Comparison of Listening and Non-Listening Behaviors (Harrisberger, 1994; Wankat, 1979, 2002)**

<table>
<thead>
<tr>
<th></th>
<th>Non-listening behavior</th>
<th>Listening behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time limitations</strong></td>
<td>Does not mention time, but is obviously busy and tries to shorten the interview</td>
<td>Honest about time limitations</td>
</tr>
<tr>
<td><strong>Climate</strong></td>
<td>Defensive and Judgmental—</td>
<td>Open and Supportive—</td>
</tr>
<tr>
<td></td>
<td>1. Evaluates and judges</td>
<td>1. Non-evaluative and non-judgmental</td>
</tr>
<tr>
<td></td>
<td>2. Tries to control speaker</td>
<td>2. Problem-oriented</td>
</tr>
<tr>
<td></td>
<td>3. Uses strategy</td>
<td>3. Honest and spontaneous</td>
</tr>
<tr>
<td></td>
<td>4. Neutral, avoids feelings, or fakes caring</td>
<td>4. Accepts and shows feelings, caring</td>
</tr>
<tr>
<td></td>
<td>5. Shows superiority: sometimes with arrangement of office.</td>
<td>5. Sets up an equal environment</td>
</tr>
<tr>
<td></td>
<td>6. Certain and dogmatic about conclusions</td>
<td>6. Tentative about conclusions</td>
</tr>
<tr>
<td><strong>Focus</strong></td>
<td>1. Internal: self-conscious</td>
<td>1. On speaker</td>
</tr>
<tr>
<td></td>
<td>2. External: on other work</td>
<td>2. On speaker’s topic</td>
</tr>
<tr>
<td></td>
<td>3. Visual: does not watch speaker</td>
<td>3. Looks directly at speaker</td>
</tr>
<tr>
<td></td>
<td>4. Interaction: on mechanics of conversation</td>
<td>4. On what is being communicated</td>
</tr>
<tr>
<td></td>
<td>5. Telephone rings: answers</td>
<td>5. Does not answer phone: signals student is more important.</td>
</tr>
<tr>
<td><strong>Non-verbal behavior</strong></td>
<td>Non-attending: closed posture, expressionless face, faces away from speaker</td>
<td>Attending: open posture, shows facial expressions, looks at and leans toward speaker</td>
</tr>
<tr>
<td><strong>Dialogue</strong></td>
<td>No dialogue: either silent or monopolizes conversation, asks closed-ended questions,</td>
<td>Dialogue: reflects, summarizes speaker, clarifies unclear points, asks open-ended questions</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>Appears disinterested and bored</td>
<td>Appears interested</td>
</tr>
</tbody>
</table>
and staying late also shows accessibility and interest in the students. This technique is one of the few methods which are efficient and effective for both students and professors, and we strongly recommend that you try it. Since there are minimal barriers to the students, the hall can also be an effective place for informal student contacts. Professors who are open, friendly, and know the names of their students are often asked questions in the hall. Many of these questions can be answered immediately. For questions requiring more time or the use of a board, you can make an appointment with the student or invite her or him into your office immediately. Taking a student with you into your office is one way to encourage students who otherwise would never come on their own.

Office hours are useful for the “regulars” who will use them. Unfortunately, many students, particularly introverts, who could benefit from help, do not take advantage of a professor’s office hours. Directly inviting students to come see you appears to be the best way to signal to students that you are approachable (Griffin et al., 2014). Encourage the whole class to visit both you and the TA during office hours. (Of course, be sure that both you and the TA keep office hours.) Private notes on returned homework and tests asking students to come in and see you or the TA can also be effective. In lower division courses it may be appropriate to tell struggling students that they must come in. This fits in with our general strategy of being more directive to beginning students. Some professors require all students to stop in early in the semester as a way of getting to know them. This also reduces the barrier to students’ coming to see you.

Telephones, Skype, and text messaging can also be used for long-distance tutoring. For television courses at remote sites, telephone, Skype or text messaging contact with students is indispensable. A specified time may be set aside when the professor will be available for phone calls about the course. Most students never use this service, but the existence of the service is important psychologically. Similarly, set-aside hours with the TA or the professor available to answer phone calls or text messages can be used for on-campus students. This service is particularly valuable for commuters who might find it difficult to come in for scheduled office hours. Text messaging can obviously be used at any time, but during these set aside times responses will be quicker. Walton et al. (2012) suggest using Google Voice (https://www.google.com/voice) for text messaging as it allows the instructor to respond in the same way as responding to e-mail and the instructor does not need to use his/her personal phone number. Of course, e-mail is a useful method for communicating with students (Hannon, 2001), but don’t be surprised if students never check their e-mail.

Should you give your cell or home telephone number to students and encourage them to call you? This is your decision. Some professors do this and some do not. If you do, it is appropriate to set limits on when they can call.

10.3.2. Advantages and Disadvantages of Tutoring

Tutoring and lecturing can fill complementary functions, as shown in Table 10-2, but they also differ in their ability to satisfy some of the basic learning principles listed in Section 1.5. This comparison is shown in Table 10-3. A complete course package of lectures, tutoring, homework, and tests can satisfy all the learning principles; however, try to satisfy as many of these as possible without tutoring since many students will not come in for tutoring.
10.3.3. Goals of Tutoring

The definition of good tutoring depends upon the goals of tutoring. The professor’s goals are often to make a student a better, independent problem solver. Other possible goals include getting to know students better, receiving feedback about what they understand and do not understand, having an opportunity to interact more with them, motivating them to learn the material, stretching and challenging them, and minimizing the time spent tutoring.

Students often have a different perspective. Many want an answer to their current difficulty and are not concerned about overall development as a problem solver. However, some students are genuinely concerned about learning the course content and want to become better problem solvers. Some use tutoring as a shortcut to finding information that they could clearly obtain on their own. Overly dependent students often want to check that they are doing everything correctly. They want reassurance. Students with a high need for affiliation may want to get to know the professor and use office hours for this purpose.

The dilemma for you is to satisfy your goals and at the same time satisfy enough of the student’s goals. Except for highly dependent students, students whose goals are not satisfied
will not return. This minimizes the time you spend tutoring but does not satisfy any learning objectives. Various methods can be used to improve tutoring.

### 10.3.4. Methods to Improve Tutoring

Tutoring is an art. A tutor must continually make decisions about what will be most helpful for a student at a particular time. Sometimes only a short answer or a pat on the back is needed. In other cases significantly more time is required.

Tutors can individualize the instruction for a particular student. Since different students want and need different things, vary your approach and responses. Observe and listen closely throughout the semester. When you meet their wants, students will be happy and motivated. Unfortunately, this may not satisfy the students’ needs. Someone who has trouble generalizing solution methods wants to see the solution method applied to all possible cases. What he or she needs is to learn to generalize. Good tutoring may consist of showing one additional case to satisfy his or her wants. Then the tutor can show how to generalize from the base case to the new case, and follow this by making the student generalize to another new case.

Students prefer that tutors point out their mistakes and show them the solution path. However, Razzaq and Heffernan (2004) note that for effective tutoring, “tutors should not offer strong hints or apply rules to problems themselves when students make mistakes.”

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### Table 10-3. Satisfaction of Learning Principles

<table>
<thead>
<tr>
<th>Learning Principles</th>
<th>Lecture</th>
<th>Tutoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Active learner</td>
<td>Often no</td>
<td>Usually yes</td>
</tr>
<tr>
<td>2. Feedback</td>
<td>Usually no</td>
<td>Can include</td>
</tr>
<tr>
<td>3. Knows objective</td>
<td>Can transmit in lecture</td>
<td>Could check on: seldom done</td>
</tr>
<tr>
<td>4. Motivate learner</td>
<td>Can happen: often doesn’t</td>
<td>Reinforce motivation</td>
</tr>
<tr>
<td>5. Individualize</td>
<td>Difficult</td>
<td>Yes</td>
</tr>
<tr>
<td>6. Important types of learning:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concepts</td>
<td>Yes</td>
<td>Can clarify</td>
</tr>
<tr>
<td>Apply principles</td>
<td>Sometimes</td>
<td>Yes</td>
</tr>
<tr>
<td>Illustrate problem solving</td>
<td>Can do</td>
<td>Can give practice</td>
</tr>
<tr>
<td>7. Problem solving</td>
<td></td>
<td></td>
</tr>
<tr>
<td>requirements:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acquisition knowledge</td>
<td>Yes</td>
<td>Can clarify</td>
</tr>
<tr>
<td>Correct misconceptions</td>
<td>Rarely</td>
<td>Difficult but possible</td>
</tr>
<tr>
<td>Practice</td>
<td>Usually no</td>
<td>Yes</td>
</tr>
<tr>
<td>8. Structured hierarchy material</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>9. Thought-provoking questions</td>
<td>Can do</td>
<td>Can do</td>
</tr>
<tr>
<td>10. Professor enthusiastic</td>
<td>Can show</td>
<td>Can show</td>
</tr>
</tbody>
</table>
learn more if they reason out the answer themselves. Good tutors should “let the students do most of the work in overcoming impasses, while at the same time provide as much assistance as necessary.” The tutor must strike a balance between letting the students find their own path and preventing them from going on a path that is “unproductive and unlikely to lead to learning.” Good tutors make numerous brief comments while students are learning, but it is important that the tutor fade, removing some of the support, as the student demonstrates proficiency. Usually, there is a remedial response for every student error, but with more advanced students the tutor might delay feedback to give the student a chance to find and correct the mistake. Excellent tutoring requires judgment. Change the questions and comments if the student repeats an error. Untrained tutors and professors tend to give lengthy explanations or answers, but these do not correlate with deep learning (Zemke and Elger, 2008). Instead, tutors need to be taught “to substitute open-ended content-free prompts for explanations.” For example, “What will you do next?” Or “What are you trying to determine?”

In Section 15.2 we will see that people construct their own knowledge structure. One of the modern tenets of helping people learn is to start with the student’s preexisting knowledge structure, and if the structure is incorrect to work to correct misconceptions. Unfortunately, untrained tutors “routinely overestimated what the tutees knew correctly and underestimated what the tutees knew incorrectly” (Zemke and Elger, 2008). This statement is also true of many professors. Tutor training needs to emphasize exploring what the tutee’s pre-existing knowledge is and focusing tutoring actions within the tutee’s knowledge frame. The four tutoring actions recommended by Zemke and Elger (2008) are:

1. **Refinement.** Prompt correction or refinement of pre-existing knowledge.
2. **Guided assistance.** Provide brief just-in-time assistance as the tutee solves problems.
3. **Problem structuring.** Work with the tutee to develop a structure for problem solving.
4. **Infusing.** Provide calibrated amounts of new knowledge on a just-in-time basis.

Students also require different emotional responses. One student may respond to a challenge, while another may require initial hand holding and encouragement. Some students respond well to the Socratic approach; others become flustered and frustrated. What works best also varies from day to day. Right after a difficult test is not the time to offer another challenge. By observing and listening to a student, you can get an idea of his or her emotional state. Then respond accordingly.

One important way to improve tutoring is by improving listening skills (Section 10.1). Be nonjudgmental. It doesn’t help a student when he or she is yelled at and called stupid. This requires patience. Without jumping to conclusions, try to find what the student’s difficulties really are. Ask open-ended questions to help the student find her or his own mistake. Whenever the problem is nontrivial, encourage the student to talk. Some focus on emotions can be helpful. A very short comment such as “I see you’re really frustrated” can have a remarkable effect. It frees up the student, helping her or him see you as human and to feel that you understand.

Listening is particularly important when a student has subtle misconceptions. Conceptualize what the student is thinking and compare his or her approach to possible correct approaches. Since words can hide the student’s misunderstanding, ask the student to write equations or draw a figure. This can help you see what he or she is talking about.

Interest in helping students is another important ingredient in excellent tutoring. You have to want to help students, although the reason why you want to help is probably not very important. Interest is important because a student can sense it from many verbal and nonver-
bal clues. Interest is also important as a motivating force for the professor. Tutoring can be hard, frustrating work. Being interested in helping students provides the patience and energy needed to be an effective tutor.

When a student comes in for tutoring, the passive lecture approach has not worked. Make the student do things—explain an approach in detail, write equations on the board, or solve problems on paper. Involve the student in the process instead of giving another mini-lecture. After you explain something, don’t accept the polite but often meaningless, “I understand.” For example,

Professor: Do you see it now?
Student: Yeah, I understand.
Professor: Good, now finish this problem on the board.
Student: You mean right now?

This forces the student to become actively involved. It also allows you to observe and correct mistakes as they occur. Give minor help, and allow the student to work the problem through to completion. This can provide confidence that he or she can solve the problems. This procedure works in the student’s zone of proximal development where, with help, problems can be solved (Section 15.5).

Another way to make the student be active is with probing questions that eventually lead her or him to the desired solution. Unfortunately, in our experience this does not work with all students. When it does work, it is a fine method for making the student reason his or her way through a problem.

Another method is to have the student explain your answer in her or his own words. Sometimes you’ll answer one student’s question and then have a second student come in and ask the same question. Ask the first student to explain the answer to the second student. This forces the first student to be active, gives you a chance to check on understanding, and fulfills the learning principle of having students teach.

Students often know concepts but are unable to use them to solve problems. Since problem solving is an art, the one-to-one contact of tutoring can help students improve their techniques. Many students have no idea how they or anyone solves problems. When tutoring, use the problem-solving strategy taught in your course. This may involve only one or two steps of the strategy or may involve going step by step through an entire problem.

For example, when a student is having trouble getting started, going over the Define and Explore steps is appropriate (See section 5.4).

Professor: OK, let’s define the problem.
Student: Well, it’s written down here.
Professor: Go to the board and draw me a figure.
Good, now label all knowns.
OK, what are you asked to find?
Good, that defines the problem. What’s the next step?

Student: It’s to explore.
Professor: What does explore mean?
Student: Look for different possible approaches.
Professor: Right. Give me five different ways you might be able to solve this problem.
Student: Five?
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Professor: Uh-huh. If you only have one, you’re not exploring.
Student: Well, I could . . .
Professor: Good, now let’s go on and work on the most likely approach.
Which approach is most likely to work?
Student: I think that the . . .
Professor: Fine. Now let’s plan how you would do that.

This approach does not produce an experienced problem solver immediately. However, it does guide the student toward improving.

When a student has put in considerable effort but is not converging on the right answer, troubleshooting is called for. Knowledge of typical student mistakes is helpful. Beginning students often have trouble with unit conversions or forget to convert units. A brief study of tests and homework will show you what the typical errors are in your subject.

If the difficulty is not a typical mistake, then more subtle errors must be searched for. This is where expert knowledge of the area becomes important. An expert can evaluate different approaches and find subtle errors. Really excellent tutors must be subject matter experts, but not all subject matter experts are good tutors. How many times have you heard some variant of “He really knows the material, but he can’t get it down to our level”? Good tutors need knowledge of the subject, but do not have to be experts. The other ways to improve tutoring appear to be more important than becoming a subject matter expert. This is why students often make good tutors.

Several little tricks can help in tutoring. Professors with a good sense of humor are well liked even if they are hard taskmasters. Humor can defuse anxiety, making learning fun. Groups of students can often be tutored at the same time. Since they often have similar difficulties, students can learn from others’ questions. The exception to this is the student who is totally lost and needs individual attention. A final suggestion is to talk to your colleagues or consult with your university’s learning center. Find out what works for them with particular students.

10.3.5. Tutoring Problems

Good tutoring with students who are initially lost is a slow process. Thus, finding enough time is the number one problem. How do you find enough time to prepare lectures, tutor, do research, attend committee meetings, and do everything else which needs to be done? Tutoring requires time, and it helps to be efficient with other tasks (see Chapter 2). One method which can help you control your time is to set specific office hours for tutoring. Unfortunately, this solution can generate a new problem. What do you do about students who come in at times other than your office hours? One possibility is to respond, “I’ll help you this time, but in the future please come during office hours.” Alternatively, if you cannot help right now you can respond, “I’m sorry, I can’t meet now. Let’s check schedules and find a time to meet.” Perhaps the problem is you have picked office hours that are not convenient for students. Ask the students what hours would be most convenient for them.

The overly dependent student is another problem. To become an independent problem solver this student needs to be weaned from the professors. The student is probably getting what he or she wants, but not what he or she needs. One approach is to discuss dependence with the student. This needs to be done in a nonjudgmental fashion. For example, tell the student that employers expect their engineers to be relatively independent, and that you are worried that he
or she is not learning this skill. If the dependent behavior persists, you may have to limit the student to a specified number of minutes per week. This ploy is most effective if every professor who has the student agrees to this treatment. Fortunately, this extreme behavior is rare.

The opposite problem is the extremely shy student who may not ask for help even when he or she would benefit from it. Encourage the student. If this student does come in, force yourself to listen even if you are very busy. One interpersonal mistake may drive a shy or sensitive student away. For a shy student to go to a professor’s office is an act of courage. By being too busy or locking your door you may destroy this courage.

10.4. ADVISING AND COUNSELING

Probably the most neglected area in engineering education is advising, and certainly this is the area where students show the least satisfaction (Wankat, 1986; Panitz, 1995). Before ABET-2000, inadequate advising was a commonly cited deficiency during ABET accreditation visits. Eble (1988) called advising in college “a mess.” Hewitt and Seymour (1992) found that inadequate advising was a frequent complaint of students who left engineering. Schwehn (1993, p. 11) stated “Few believe that academic advising should be rewarded; it seems to almost all faculty an irksome task at best.” Twenty years ago these negative comments were all too often valid. Since the first edition was published, we believe that advising has improved significantly at many schools. One way many schools improved advising was to remove most advising from professors, who usually placed advising a distant third behind teaching and research, and placed advising in the hands of people hired to be advisors. At these schools professors and advisors will both be more effective if they work together. At institutions where professors do extensive advising some knowledge of how to improve the process will be helpful. In this section we will first discuss academic advising and then helping students with personal problems. Professional counselors often draw a distinction between advising and counseling, but we will use these two terms interchangeably.

10.4.1. Academic Advising

Advisors need to be trained to do academic advising (Drake et al., 2013; Wankat, 1986, 2002). This is true for professors, peer (student) counselors, administrative assistants, and professional counselors. Training is required for the specific information needed, in listening skills, and in specific counseling skills. Unfortunately, only about a third of US campuses provide faculty advisors training while only a fourth of the campuses require training (Habley, 2000). Model training programs for faculty, peer counselors, and professional counselors will be different because each group has different needs (Farren and Vowell, 2000).

Studies (e.g., Light, 1990) have found that there are significant gender differences in what students want from their academic adviser (Table 10-4). To some extent they may mirror differences in the percentages of men and women who are feeling or thinking types according to the Myers-Briggs Type Indicator (see Chapter 13). The implication for advising is that procedures that work for men may not satisfy women. Tannen (1990) notes that in general men communicate facts and try to maintain independence, whereas women search for rapport and connections. Within this general framework Table 10-4 makes sense.
CHAPTER 10

First, an adviser’s information must be accurate and up-to-date as to the university’s requirements for registration, prerequisites, dropping and adding courses, probation, transferring to a different college within the university, grade appeals, and so forth. The adviser needs to be able to tell a student the consequences of doing or not doing something. If the adviser does not know an answer, he or she needs to know whom to ask to find out. At large universities keeping up to date is a nontrivial task since courses, graduation requirements, and rules are continually changing. Advisers probably need to attend a meeting every semester to refresh their memories and to learn about changes.

A major role of advisors is to provide referrals. Offices that advisors may want to refer students to include:

- Career center
- Cooperative education
- Disability student assistance
- English as a Second Language (ESL)
- Financial Aid
- Immigration
- International students
- A campus organization or club where the student where will feel he or she belongs. Light (2001, p. 98) states this is often “the single biggest contribution an adviser can make.”
- Study abroad
- Transfer advising
- Tutoring
- Veteran’s affairs
- Writing center

Resources for students with serious problems are listed in Section 10.4.2.

Each school has a slightly different philosophy about advising. We believe that the responsibility for obtaining an education is the student’s. The adviser is there to help, provide information, and explore alternatives, but the student retains the ultimate responsibility. Thus, advisers need to help students gradually become more responsible in such things as checking for errors on a schedule, selecting a major, selecting electives, getting to know a few professors well, and eventually deciding upon graduate school or an industrial position.

Since the ultimate responsibility lies with the student, we recommend a relatively non-directive approach until it is clear that a proactive stance is needed. Let the student do most of the talking while you listen, empathize, probe, tell the student the probable consequences

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Note: Table shows percentage of respondents saying “very important.”

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Since the ultimate responsibility lies with the student, we recommend a relatively non-directive approach until it is clear that a proactive stance is needed. Let the student do most of the talking while you listen, empathize, probe, tell the student the probable consequences
of a particular action, and then let the student make the decision. Of course, there are certain actions, such as taking a course without the prerequisites, which may not be allowed, but if the action is allowed, the student should make the final decision. The adviser’s expertise is important in explaining the consequences of actions. For example, many students are unaware of the consequences of being dropped from the university. Or, a student may not realize that dropping a particular required course will delay graduation by one year.

Many lower-division students are not ready for the responsibility of conducting their own affairs. A fairly proactive or prescriptive stance is appropriate for lower division students when there are signs of problems, such as excessive absences, D and F grades, probation, failure to register on time, and so forth (Drake et al., 2013). Phone calls, e-mails, letters, and personal visits can help prevent a student from getting into serious trouble. Students often just let things go because they do not understand the probable consequences of their actions. A formal written contract with the student may be appropriate (e.g., to find a tutor). Since the student is irresponsible, the adviser needs to keep notes on what has happened and what agreements have been made.

With freshmen and sophomores it is appropriate to discuss academic skills if students are having problems. Engineering professors often assume that students know how to study and understand the tricks of taking tests. Many students have not learned these skills. Study methods, problem solving, test taking tricks, relaxation methods, and methods for budgeting time can all be useful to such students. These academic survival skills can be covered informally in small groups, and students can be encouraged to form study teams. Many universities have programs available through a counseling office or the psychology department. Learning these methods and skills requires that students construct the knowledge necessary (see Chapter 15), and practice plus feedback are essential.

Upper-division students are likely more mature, and with them a more laissez-faire approach is often appropriate. There are skills which these students probably have not learned that will be useful. In particular, interview techniques and decision making are of considerable interest to seniors. These can be taught in seminars or small groups. Individual attention with a professor who is familiar with a given industry or with several graduate schools can be extremely helpful. Although students want to hear the professor’s opinions, it is still important to listen to them and let them make the decision.

At large universities it is surprisingly difficult to be sure that all or even most students understand what they are supposed to do for registration, dropping classes, company interviews, and other official tasks. Try a variety of different modes of communication. Seminars, announcements in class, bulletin board announcements, letters, e-mail, learning management system, catalogs, advertisements in the student newspaper, and individual discussions will each reach a few students that the others won’t. The failure of a student to know the rules is not an excuse, but try to reach as many students as possible. Since this problem reoccurs every year, patiently keep trying to communicate.

Advisers often spend a great deal of time on routine matters such as registration. There are ways to make this and other routine matters more efficient. Records should be computerized to remove this burden from the advisers. Registration can be handled efficiently by the combination of a group seminar and/or mass e-mail to provide information and individual sessions with the counselor for final course selection. Individual sessions are important to
avoid losing students and to give the adviser an opportunity to question the student’s course selections. Some students sign up for inappropriate courses for a variety of reasons. The adviser can catch this by asking questions.

Hiring a professional counselor, empathetic administrative assistant, or peer adviser (an upper-division student) can be a cost-effective way of reducing the burden on engineering professors while simultaneously increasing the effectiveness of advising (Panitz, 1995). The routine bookkeeping, processing of forms, and enforcing of discipline do not have to be done by professors. They can better spend their time advising students on professional decisions involving the choice of electives, graduate school, or industrial jobs. Students generally rate professional advisors highly on information about curriculum and which courses to take (Sutton and Sankar, 2011). They are less satisfied with information about which professors would be better teachers, who to choose as a mentor, and what alternate majors should they consider. Professional advisers and professors need to work together to maximize the positive effects of good advising such as better retention and more satisfied students.

Students are also likely to ask their advisor or any professor they get to know about career opportunities. The first place we send students is to our university’s career center. For additional information the internet is a good place to start. An excellent source for resume preparation is the Purdue Online Writing Laboratory (OWL), https://owl.english.purdue.edu/owl/. For written material about job searches, interviewing, negotiating, networking, and so forth check out the Purdue Center for Career Opportunities online guide, http://crmpubs.com/CGsFinal/Purdue_CPG13-14_Online/Purdue_CPG13-14_Online.html. For a source with a number of good quality videos on various aspects of job hunting have your students check out the York University Career Centre, http://www.yorku.ca/careers/cyberguide/introduction.html.

At large universities many students seldom have the opportunity to speak individually and confidentially with any university employee—with the lone exception of advisers. It is important for advisers to be open and take advantage of this opportunity. Use of listening skills and empathy may lead the conversation from a rather mundane presenting problem to more serious concerns. The term “presenting problem” refers to a problem that is raised by the student but which may conceal another problem—the one needing to be addressed. Oftentimes an adviser is the only official at the university who has taken time to listen. This caring can make a major difference in the student’s career, and many times is what keeps a student in school. Doing this requires interest, time, and counseling skills, which are the subject of the next section. Bullard (2008) discusses the human side of advising in detail. She recommends that advisors:

- Learn and use all of your advisees’ names.
- Take time to chat about the student’s summer plans, family, hobbies, etc.
- Put a clock in a place where you can easily see it while chatting with students.
- Let the students see that you are a real person with a life outside of work.
- Show the students that you care.
- Organize your job and train assistants so that you have time for students.

### 10.4.2. Counseling Skills for Personal Problems

Advising students on personal problems is not, and in our opinion should not be, a major role of engineering professors, but it is sometimes required. The procedures used for dealing with
personal problems are often useful for academic and career counseling. A simple crisis intervention model useful for short-term interventions will be presented (Edwards, 1979; Wankat, 2002). Professors should always aim for short-term intervention with students with one or at most two sessions. If the professor has a student in class, then great care should be taken in counseling him or her on personal problems. The roles of teacher and personal counselor are in many ways incompatible (Lowman, 1995). Professors should be aware of the resources on campus so that they can refer students to additional help. Useful offices to look up on your campus are those that deal with the following issues:

- Academic regulations and policies
- Community crisis center
- Counseling center
- Dean of Students
- Emergency response team
- Health center or hospital
- Financial aid
- Psychiatric services
- Sexual harassment/assault support services
- Student conduct office or Dean of Students office
- Student legal services

An ABCF model can be used to help students deal with a crisis (Edwards, 1979; Wankat, 2002). The four steps in this crisis intervention model are:

A. Acquire information and rapport. Students who come in to talk to an adviser very often have a presenting problem which is the first thing they talk about. The presenting problem is real and often is the only problem. However, there may be other problems hiding behind it, which the student would like to talk about if given the opportunity. Advisers who are open and use listening skills give students the opportunity to discuss these deeper problems. In addition, there are often other signs of serious problems that can sometimes be noticed by casual observation: excessive absences, sudden plummeting of the quality and quantity of work, the smell of alcohol on the person, slurred speech, and so forth (Civiello, 1989).

Once it is clear that there likely is a problem, the adviser uses active listening skills to acquire information and establish rapport with the student. Empathy, which may be crucial for gaining rapport, involves knowing what it is like to walk in that person’s shoes. It can be obtained by focusing on feelings since the feelings of sadness, anger, fear, happiness, and so forth are universal. The adviser may not have been in a situation similar to the student’s, but he or she will have felt similar feelings. With this focus on feelings some students may become quite emotional and start crying. Signify that this is OK, give the student a tissue, and let him or her cry. The short book by Mayeroff (1971) is useful for insights into empathy and caring.

Individuals often skirt taboo subjects, but they probably want to talk about these issues. It is permissible to bring up issues such as death, AIDS, suicide, poverty, and broken relationships. (This can be difficult for the teacher who has to evaluate performance in class.) If you bring up a topic that is not the problem, the student will correct you. Probe, but encourage the student to do 90% of the talking.

The classic error of people learning to use this model is to go too fast in the acquiring step. Often counseling should stop at the acquiring step. People, particularly women, may
want a confirmation of feelings, not problem solving (Tannen, 1990). This behavior is more likely to occur with peers who are of equal status than with students.

B. *Boil the problem down.* Sometimes the student knows what the problem is and sometimes he or she has not accepted what the problem is. If it seems clear to you that the student knows what the problem is, it is OK to ask, “What’s going on here?” Follow this with silence to give the student time to collect her or his thoughts. When the problem is unclear, an important function of a counselor is to help the student clearly state the problem. While in the acquiring stage you can hypothesize about the problem. Then explore if this is a possible problem by probing with open-ended questions. When there is sufficient evidence, formulate a problem statement and check it with the student. Do this in a tentative fashion. “It seems that the underlying problem is . . . ” If the student agrees or modifies the statement slightly, then you are ready to move on to step C. If not, return to step A.

C. **Coping: help the student cope.** If we think of working with students on personal problems as problem solving, then steps A and B are the define stage. Step C consists of explore and plan stages. The adviser helps the student devise a plan to cope with the problem. Since it is the student’s problem, it is not helpful to give advice. Explore alternatives and try to get the student to set up an action plan. This may be difficult.

There are problems in which the situation cannot be changed but must be accepted. For example, a death in the family or a parent who is dying of cancer do not have solutions. However, there are actions that may help the student, such as joining a support group, seeing a professional counselor, obtaining extensions on assignments and exams, or taking incompletes in classes. Explore these possible actions.

As a counselor you can serve as a resource person during the coping step. Students often do not know what resources are available on campus or in the community. They can be referred to the university counseling center, the office of the dean of students, the student hospital, the financial aid office, the local crisis center, or whatever else is appropriate. It may be helpful to call the referral office and make an appointment for the student with her or his permission.

F. **Follow-up.** The student needs to go out and actually carry out the action plan. It is sometimes appropriate to schedule one follow-up session to check on his or her progress and offer encouragement. This follow-up can be suggested informally (“Stop in and see me when you’ve gotten this resolved”) or formally (“Can you come in and see me at this time in two weeks?”) Whether or not a follow-up is appropriate depends on your judgment.

One paradox of helping is that the more severe the crisis, the less training the adviser needs. Natural caring and empathy are often sufficient for acute problems. Students with long-term chronic problems and dysfunctional students require trained professional counselors, social workers, or psychologists. Refer these students to the appropriate professionals.

**10.4.3. FERPA (Family Educational Rights and Privacy Act)**

Who can you tell about a student’s difficulties? The answer is heavily influenced by the Family Educational Rights and Privacy Act (FERPA, 2014). This law gives parents the right to inspect their children’s educational record, but at the age of 18 or when the student enters college this right transfers to the student. The law also restricts who the college can share the records with unless the college has permission from the student. FERPA means that professors can only
discuss a student’s grades with the student’s parents with the student’s consent. This can lead to some rather interesting discussions with irate parents.

FERPA does allow sharing records without consent to other school officials who have a legitimate educational interest, schools the student is transferring to, the financial aid office, accrediting agencies, law enforcement agencies when there is a judicial order of subpoena, and appropriate officials in health and safety emergencies. Certain “directory” information such as name, address, telephone number, dates of attendance, honors and awards, and date and place of birth can be shared without permission.

Since the interpretation of FERPA requirements varies from school to school, discuss the requirements with the Dean of Students Office if there are questions.

In cases where you are concerned that the student may hurt him/herself or someone else, contact the appropriate office (emergency response team or police department) first and worry about FERPA later.

10.4.4. Learning Communities

Any process that fosters student engagement will increase the retention of first year students. One approach is to build a learning community in which students live, take classes, and study together (Smith et al., 2004). Although generally helpful for most students, learning communities are particularly useful for students such as underrepresented minority or women engineering students who might otherwise be isolated. Since they take the same courses and are often in the same sections, students in a learning community generally find it easy to develop study groups of students in the same residence hall. Students in a learning community also find it easier to become socially adjusted to college (King, 2000; Smith et al., 2004), which will help increase retention (Tinto, 1994). The How People Learn model (Section 15.5) shows that most people learn better if they are part of a community of learners.

In many ways learning communities recreate the ambience of a small residential college where everyone lives on campus, eats at a common dining room, and feels comfortable with the college. Learning communities are needed because most students no longer attend residential colleges with a few hundred students per entering class. New students can easily become isolated at large state universities with 20,000 or more students. Students in a learning community are significantly less likely to become isolated.

There are potential unintended consequences of first year learning communities (Jaffee, 2007). The homogeneity that the learning community provides can re-create a high school environment that is not scholarly and inhibits serious study. Although resident advisors are available, the typical lack of older, more experienced students in the learning community also removes normal, informal peer mentoring. Because of the cohesion of the learning community students, they normally adapt well to active learning approaches, but they may resist more authoritarian lecture approaches.

Many engineering programs started learning communities with NSF funds in the 1990s. The programs are successful at increasing retention and graduation rates (Smith et al., 2004; Taylor et al., 2003). This success at increasing retention led a large number of institutions to keep or start learning communities for engineering students, even though these communities are no longer supported by the federal government.
You can help by first supporting the efforts to develop and continue learning communities. Learning communities are often run by the Office of Student Affairs or the Office of the Dean of Students, offices often ignored by faculty. A little support does not take much effort and will probably be very helpful to the success of the learning community. Second, encourage potential and new students to join a learning community. If you want to become more involved a third approach is to volunteer to serve as a faculty advisor or faculty fellow.

10.5. RESEARCH ADVISERS

An extremely important type of one-to-one teaching involves being a research adviser. This role is closer to the tutoring role than that of an academic adviser or personal counselor, although it has elements of all these roles. Engineering research advisers have two major objectives: to help students develop and become competent researchers, and to do research and publish the results. Although usually complementary, there can be conflicts between these two objectives.

Professors are always seen as role models—either good or bad models. This is particularly true for research advisers who need to behave ethically at all times. Unfortunately, ethical problems between research advisers and students are all too common although engineers are not the worst offenders (Swazey et al., 1993). Advisers who adopt and follow the guiding principle “to do what is best for the student at all times” (Wankat, 2002, p. 206) will not have ethical problems.

All students doing engineering and scientific research need to be socialized into the values of scientific research. Although modeling ethical behavior is important, it is not sufficient. There needs to be a continuing discussion in group or private meetings of the high research standards of the group. Examples of group research values include the need to prove that data is reproducible, reporting and discussing all data within the group, and the need to understand data before publishing it. In addition, any research group larger than one person needs to have policies for allocating authorship, citing papers, and acknowledging other assistance. The COSEPUP (2009) brochure and Steneck (2007) are excellent resources for guidance on responsible conduct of research.

10.5.1. Undergraduate Research

A research experience can be extremely valuable for undergraduates, and strong arguments can be made that a senior thesis should be required (Prud’homme, 1981); or if classes are large and resources limited, undergraduate research should be an encouraged option (Fricke, 1981). Research can give students the opportunity to explore a particular topic in greater depth than would be possible in class. The student can receive individual attention from one professor and get to know this person well, which is very useful when the student needs reference letters. Undergraduate research allows the student to “try out” research to see if graduate school should be considered, and it helps the student improve her efficiency, time management skills, and ability to schedule complex projects. Individual meetings with the advisor provide practice in informal technical communication—an important skill in industry. If teams are used, the student will learn how to function in a team.

Most undergraduate engineering students in the United States have little experience in working independently on a large project. Thus, initial supervision needs to be much more structured than for an advanced PhD student (COSEPUP, 1997). An undergraduate may
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need to be taught laboratory skills which professors normally assume graduate students know. Making a graduate student/post-doc the supervisor of an undergraduate provides for much of the day-by-day assistance the undergraduate needs. In addition, the experience at supervision is useful for the graduate student/post-doc. With this arrangement professors can meet with the team once a week, review progress, and provide ideas.

The selection of projects for undergraduate research is critical. Real problems which push the knowledge level of the student are appropriate. However, the project must be doable in a finite amount of time. Exploratory projects are inappropriate for undergraduates (COSEPUP, 1997). To progress in one semester, the student must have taken the appropriate prerequisite courses. Team projects can be significantly more complex than individual projects. Reporting of results in both written and oral form should be part of the project requirements. If possible, it is very motivating to list the undergraduate as a coauthor of a paper.

Professors need to be aware of the differences between undergraduate and graduate researchers so that they do not expect too much from the undergraduates. Compared to graduate students, undergraduate students usually have limited time, less background in the subject, lack self-confidence in doing research, and are uncertain of their interests (Luck, 1998). However, undergraduates can bring fresh energy and fresh, naïve questions to the project.

10.4.2. Graduate Student Research

In most schools the major goal of research programs, particularly the PhD program, is a research project and the thesis which results. Then the role of the research adviser becomes critical. This role really has no equivalent in undergraduate education, and in many ways it is essentially unchanged from that of medieval tutors. At some schools the research adviser essentially controls when the graduate student graduates, how long the graduate student is funded, what the project is, whether or not the student goes to conferences and so forth. Once the student signs on with a given advisor, he or she may lose many rights. Obviously, the adviser has significantly more power than the graduate student in the relationship.

Unfortunately, engineering advisors, particularly untenured faculty, face a built-in conflict of interest with their graduate students. Professors want to obtain research results and publish papers quickly. Much of the time this goal is aligned with the students’ best interests. However, there are times when the best interests of students and the professor’s desire to publish quickly are not aligned. For example, internships while a graduate student are extremely helpful for international students who want to obtain a job in the US after graduation. However, internships take time and students’ progress on their thesis research normally stops. A second example is senior graduate students who have learned to be independent researchers and are now rapidly obtaining results and writing papers. These students are probably ready to graduate, but then the professor will lose a very productive team member. The professor who always does what is in the best interests of the students will avoid conflicts of interest and be on the right track.

There will always be a few professors who will abuse their power in their relationships with graduate students, and disgruntled students always know how other students are being treated. Thus, departments need to have formal institutional policies that are enforced. Departments that have a tradition of strong graduate committees have a built-in method to control abuse. Graduate students should look for committee members that will provide skills
that complement their adviser. Since they will need to obtain recommendation letters from at least three faculty members (see Appendix A), graduate students need to start networking with these or other faculty. New professors need mentoring in becoming research advisers since they have probably had only their own adviser as a role model.

In engineering most graduate students doing research receive support. Policies on how long the student will be supported to the MS and to the PhD are useful to ensure uniformity. Such policies also help prevent advisers from keeping students too long and prevent students from abusing the system because they enjoy graduate school. Some leniency in the cutoff date is useful for exceptional cases, but the extra period of support should be limited.

The selection of a research adviser is probably the most important decision an individual makes as a graduate student. Unfortunately, the process is often random and students do not ask the right questions (Amundson, 1987). A better approach would be to train students in selection processes before they listen to faculty presentations and interview faculty members. Such training could include a discussion of differences in personality type (see the description of the Myers-Briggs Type Indicator in Chapter 13). Students could also be shown various decision methods such as the K-T decision matrix (Table 4-2). To help students develop their decision matrices, consider giving them a list of generic qualities that may be important in an advisor.

It would be helpful for students to also have some understanding of the different roles that research advisers can assume. Crede and Borrego (2012) found that engineering advisors with large research groups (more than 20 students) tended to act as managers of a business. The professor usually did not understand each individual student’s project in detail, but understood the big picture of what the group was trying to accomplish. Group funding was high and a large amount of equipment was available. New students were essentially mentored by senior graduate students or post-docs. At the other size extreme, advisors of small research groups (less than 5 students) tended to spend a lot of time mentoring their students, coaching them on research, and socializing them into research. Small groups usually had less access to equipment and fewer peers to turn to for support. Intermediate size groups tended to lie between the two extremes, except that students in groups of 5 to 10 students were more likely to agree that they knew what the professor wanted. Since mistakes are made in the selection of a research adviser, a uniform policy on allowing students to switch advisors should be followed. Some schools require all students to interview other potential advisers at some specified point such as on completion of the MS. Students who are satisfied with their current advisers attend these interviews in a cursory fashion. This policy protects the students and removes any stigma from switching advisers.

New graduate students probably are not very efficient and do not know how to do a scientific literature survey or how to schedule a long project. All these things need to be taught. Thus, there is a strong tutoring aspect to starting new graduate students and advising needs to be rather structured (COSEPUP, 1997). At the beginning of the graduate student’s tenure as a student, it is useful to have regularly scheduled meetings. Even though there may be no research as yet, there are many other things to talk about. Shortly after being assigned an adviser, ask the student to develop a project plan for when he or she wants to graduate. This makes the student think about what must be done to graduate. The plan can be revised on a regular basis as the student learns more about the time demands of the project. The student also needs to learn to balance the immediate demands of course work and research where there may be no immediate demands. Research requires accepting delayed gratification.
Some discussion with the student about background and goals is appropriate. This will help develop rapport. It is also useful to know where the student has come from (figuratively speaking) and where he or she is going in order to help design methods to motivate the student. Use active listening skills to get the student to talk about her or himself.

The classical graduate student discipline problem involves the graduate student who does not appear to be working or performing any research. Help the student set realistic goals. Sometimes graduate students stop working because they do not have a job lined up after graduation. If this is the case, you may be able to help with a postdoctoral position. If the student is supported by research funds, no work—no pay is a realistic policy. It may be possible to support the student if he or she continues working on research while searching for a job, by delaying turning in the thesis. In extreme cases stopping payment is appropriate.

Palmer (1983) lists the philosophical needs of students as openness, boundaries, and an air of hospitality. Openness is a sense that there are few barriers to learning. Admit students to the community of scholars and expect them to learn. Firm boundaries help create an open space where students can choose interesting, meaningful research, but not so open that they run wild. Research and learning can be very painful processes since they are not linear paths. Therefore, the learning space must be hospitable. Both new ideas and failures must be treated gently so that the student has permission to keep trying.

10.5.3. Masters’ Research

Thesis option masters’ research projects in some ways are longer versions of undergraduate research. Since the project must be doable in a finite amount of time, the professor probably needs to define most of the problem. Most masters’ students have just made the transition from being undergraduates. Graduation does not suddenly make them mature, self-starting individuals, and many need the same initial structure as undergraduates; however, graduate students should be made more independent fairly quickly. It is appropriate to define the problem but require the student to control the execution of the project. Ask a senior graduate student to train new graduate students in laboratory skills and safety practices. But it is probably not a good idea to use an advanced graduate student as a research supervisor. New graduate students deserve the attention of the professor.

Regular meetings of the graduate and undergraduate students in a research group can help foster a sense of belonging. A senior graduate student can be assigned to organize the meetings. The presentation of research results to the group is a useful practice on a regular basis and makes students more polished when they make formal presentations. New students can be asked to make presentations on papers from the literature. Discussion of the presentations should be critical yet friendly. The professor can ensure that this happens. New ideas should be greeted with the PMI or another positive approach (see Section 5.7.3).

10.5.4. PhD Research

When they graduate, engineering PhDs are expected to be independent researchers: able to analyze a situation, define the problem, outline a plan of attack, and conduct the research. Many companies assume that a new PhD can supervise the work of technicians. In academia the new
PhD will be expected to generate new research ideas, supervise the research of graduate students, write proposals, review papers, teach, serve on committees, and publish. If the PhD is to be able to do all these at graduation, then he or she needs guided practice in doing these activities while a graduate student. This need for practice guides our advising of PhD students.

Since the professor usually has research money for a specific area, the general area for the PhD student’s research is usually set. However, within this broad area the student needs to define the problem he or she will work on. This is a nontrivial task. The easy part involves doing a literature search to see what others have done. The professor can help the student by steering her or him to the appropriate tools in the library including computer searches. During this period, attendance at a professional meeting can help the student see what the current hot areas are.

The hard part for most students is the intellectual development often required to be in charge of the research. Determining what is important and what research should be done requires that he or she be relatively mature (see Chapter 14). Most students have always been told what to do, and they initially find the freedom of PhD research frustrating. The period of frustration can easily last a year while they work to determine “what they want.” Duda (1984) notes that many students have misconceptions about graduate research, not realizing that research is a problem-solving method and that a straight, linear path seldom works. The backtracking, dead ends, and lack of obvious progress can be frustrating.

Amundson (1987) suggests meeting with students on a regular basis until it becomes necessary to turn them loose. Then they need to be told to work on their own until they come up with something that is new and/or surprising. Most students respond amazingly well to this charge and develop independent ideas. A few start their graduate programs already independent and use the freedom to develop research on their own. A few are unable to cope and probably should be encouraged to look elsewhere for career opportunities.

When a student does present a new idea, it needs to be accepted but with the challenge that it be further developed. Ask the student to develop the idea and then prove it theoretically or experimentally. Suggest that he or she develop ten or twenty alternatives to the idea. Refuse to judge the idea since the student needs to learn how to do this.

While conducting research, a student needs to learn to do a host of other tasks. Foremost is learning to communicate. Encourage the student to review the literature and then write a review article with you. This is efficient since it accomplishes the necessary review process, helps the student learn how to write, and earns the student a publication early in her or his graduate student career. The review article can be completed before the student is challenged to become independent. Communication includes oral presentations. Students can be required to make oral presentations in group meetings and later at professional society meetings. These presentations need to be evaluated to help the student improve. Video recording some of the group presentations is a good way to encourage growth. Students should be given the opportunity to review papers and proposals, first as a supervised activity where the professor also reviews the paper or proposal and the reviews are compared and contrasted. Then, the student can review papers and proposals independently. Pace these tasks over a long period so that the student is not overwhelmed at any one time. And there needs to be plenty of freedom to learn to think; otherwise, students may escape from thinking into mindless work on other tasks.

After a student has learned to conduct research independently, he or she can help to supervise undergraduates. This supervision itself should initially be supervised. Have meetings with
the PhD student, both individually and with the undergraduate student, to discuss the progress of the undergraduate student’s research. Your supervision can then be slowly reduced.

After a graduate student has completed some research, he or she will want to write a research paper. Ideally, the first paper should be written at the time the student would write an MS thesis if the student were not going straight to a PhD. Take an active role in outlining this paper and in the necessary revisions to the paper. When the reviews arrive, give them to the student. The reviews often provide for reality testing. The student should help with revisions of the paper on the basis of the reviewer’s comments. Students should be asked to proofread galley proofs for articles—in our experience students are often more careful proofreaders than professors. Once the student has started doing independent research, he or she needs to become independent in writing papers. After experiencing the first flush of success in publishing a paper, the student may suddenly write several papers. If these are not well done, return them with a note indicating that they are not up to professional standards, but do not provide detailed comments. Rewriting is a necessary part of writing, and the student needs to master this art.

Although it may not be appropriate to place a student completely in charge of writing proposals, he or she can certainly help prepare them. Let the student share the joys or frustrations of submitting research proposals. Discuss with her or him the strategy you use for obtaining research support.

Students who intend to follow an academic career need additional teaching experience beyond being a TA. A course or self-study on teaching methods is useful. The chance to do supervised teaching of a class or seminar is also an excellent experience which far too few students receive (see Chapter 1).

Not all graduate students are happy with their advisors and not all graduate students in their first year want to develop a personal relationship with their advisor. In the second and third years they want the advisor to provide expertise, timely feedback, and be available. As they become expert in their research they want their advisor to adjust (Brown and Atkins, 1988). A common error of research advisers is to continue to be directive, to treat the student like an intelligent technician instead of as a professional, and to not provide opportunities for the student to define problems (COSEPUP, 1997). Since choosing a research adviser is probably the most important decision graduate students make in graduate school, a senior professor in the department should discuss with the cadre of new graduate students what sort of things to consider when making the decision. Spending ten minutes on formal decision methods such as the K-T decision matrix (Table 4-2) will be time well spent.

10.6. CHAPTER COMMENTS

The ways that a professor interacts with students in one-to-one situations obviously depend heavily on the professor’s personality. Some suggestions have been provided which have been found to be useful.

Section 10.4.3 on learning communities does not fit perfectly in this chapter, but it fits better here than in any other chapter. We placed it in this chapter because faculty should be aware how useful learning communities are and because these programs are often run by advising offices.

The section on being a research adviser is likely to be controversial. Many professors use very different procedures as research advisers. Obviously, there is no one best way to advise
research students. We have clearly stated our value judgments and then suggested an advising procedure which follows these value judgments. If readers do the same, then Section 10.5. will have achieved its purpose.

**HOMEWORK**

1. Set up a role play to practice listening skills. This requires that you have a partner to take the role of a student, and a facilitator to observe the interactions and record both their positive and negative aspects. The observer needs to watch the climate, the focus, and the responses (nonverbal, minimal verbal, and verbal). Several role plays should be done including the following situations:
   a. A student who did poorly on the exam and has been asked to stop by the professor’s office.
   b. A student who is trying to obtain extra points on the exam.
   c. A student needing academic advising.
   d. A student with a personal problem which is causing academic difficulty.
   e. A third year PhD student who is not making adequate progress on research.
2. List the rules and regulations for undergraduate students at your university as far as registration for classes is concerned.
3. What is the purpose of PhD education in your engineering field? Based on this purpose discuss what the ideal thesis adviser would do. Then develop a program to make your own advising more closely approach the techniques of your ideal adviser.

**REFERENCES**


