Proceedings of Meetings on Acoustics

Volume 23 http://acousticalsociety.org/

169th Meeting of the Acoustical Society of America

Pittsburgh, Pennsylvania
18-22 May 2015

Education in Acoustics: Paper 3aED5

Preparing for a career in academia: Mentoring students in research

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A new faculty member faces challenges associated with meeting and balancing various teaching, research, and citizenship demands. This includes managing students as part of developing a research program. Despite the vital importance of this skill, effective employee management is not something a student inherently learns in graduate school nor does it often receive attention as part of new faculty development workshops. This paper discusses lessons learned regarding research student management at an institution with an active student-based acoustics research group. These include setting a scholarly goal at the outset with specific result-driven milestones and clear expectations of the "end game," adopting a management style that is best suited to each student's personality, adapting the project where possible to student strengths, and helping them learn to write as early as possible. Graduate students can be trained to become effective peer mentors of undergraduate students, increasing both a sense of teamwork and overall productivity. New faculty members will benefit from actively seeking mentoring from more experienced colleagues who have successfully built student-based research programs.

Published by the Acoustical Society of America

 [DOI: 10.1121/2.0000068]
Received 01 June 2015; Published 24 July 2015

1. Background

This paper is the result of an invited talk given at the 169th meeting of the Acoustical Society of America in a session dedicated to helping students prepare for careers in acoustics, with a special emphasis on academia. The purpose of this paper is to offer guidance in preparing to become an effective research mentor.

A new faculty member faces challenges associated with meeting and balancing various teaching, research, and citizenship demands. Boice[1] has indicated that typical new faculty members spend far too little time on scholarly writing. However, those who he terms "quick starters" spend three or more hours per week on scholarly writing. He further notes that these quick starters regularly seek advice from colleagues and average four hours per week discussing research and teaching. While quality teaching and citizenship inside and outside research institutions are viewed as essential and require many hours of attention each week, it is often research productivity and impact that is the deciding factor for determining tenure. Because of the demands on the faculty member's time, it is almost always essential that the faculty member enlist the aid of research assistants.

In becoming an advisor/supervisor/mentor, the new faculty member is likely to experience a startling change in roles as the detailed work is now being carried out by the student, and he or she has the difficult job of guiding and managing the research progress while giving the student room to grow. It is noteworthy, and concerning, that *most* new faculty development workshops at universities do not cover personnel management in the myriad topics often discussed:

- Effective teaching strategies
- How to write grants
- Networking
- Navigating the tenure process
- Writing productively
- Publishing strategies
- Time management
- Balancing life and career
- Campus resources

The dearth in opportunities for formal training in student management and mentoring begs the question: "Where and/or how does the faculty member learn to be an effective research mentor?" We hope that the principles and strategies, although admittedly anecdotal, gained through sometimes painful experience and outlined here will be useful to the new faculty member. We further provide a disclaimer that "some assembly is required" and that "one size fits most." In other words, there is no single one way to become an effective research mentor and that practice with, and adaptation of, these principles will be necessary. When it comes to research mentorship, the words of the philosopher Aristotle[2] ring true:

"For the things we have to learn before we can do them, we learn by doing them."

2. Finding a Faculty Mentor

The process of becoming an effective mentor is made considerably easier by carefully observing and regularly seeking advice of a successful senior faculty member. Many departments have a formal mentoring program, but some do not. In our opinion, the definition of success for one seeking a mentor is not the one with the greatest number of publications or funding, but one who has built a productive student-based research program and that is able to manage the tensions of the various areas of faculty stewardship while balancing career and life outside the office. The counsel of Boice is worth mentioning, again – quick starters spend several hours per week discussing research and teaching with others. Learning from the experiences of others in the department will help the new faculty member avoid institution-specific pitfalls and build collegiality.

3. Recruiting Students

The mentoring relationship begins with recruiting students. Although standardized exam scores and grade point averages are valuable screening tools, admissions processes only vet certain academic abilities in potential students. A faculty member should personally interview potential students and only commit to work with those who are:

- Academically capable. A student who struggles in the classroom will not be able to devote sufficient time to research activities.
- Passionate about researching within the field of study. It is an investment of resources and time to take on a student and the new faculty member cannot afford to take on students who are not genuinely excited about the mentor's subdiscipline.
- Self-motivated, have a strong work ethic, and are willing to go the extra mile. Students with an entitlement mentality should be avoided. These intangibles are essential when it comes to taking ownership of a project and becoming a semi-independent researcher. These are difficult to discern in a student at the outset, but there are many resources online with effective interview questions that help the faculty member gain a sense of the prospective student's personality and attitudes about past experiences.

4. Establishing a Positive Mentoring Environment

The new faculty member faces many pressures regarding research funding, publications, teaching reviews, and so forth. With the need to be productive, it is easy to neglect the foundation that makes the mentor-mentee relationship more effective. Some guiding principles for establishing a positive mentoring environment are found below. Although the target audience is for youth mentees, excellent resources regarding attributes of an effective mentor are available through the National Mentoring Partnership[3].

Some of our observations include:

- Faculty should develop a positive mentoring environment for their students that includes regular affirmation for their efforts.
- At the outset, the student needs to catch the vision of who he or she can become through dedicated effort.

- Demonstrate genuine interest in the student, which inspires loyalty and productivity. Once the right student is found, remember the popular business aphorism: "Your people are your greatest asset."
- Try to ask questions about the student's prior experiences in order to adopt a management style to achieve the best result with each student.
- If necessary, this is an appropriate time to set boundaries regarding contact hours, means of communication, and so forth.

Columbia University[4] reminds us of the importance of establishing a constructive mentoring relationship and not underestimating the role that the faculty member plays with the student now and will play in the future:

> *The relationship between a mentor and a graduate student is the most influential relationship in the student's career. Effective mentors are much more than advisors or teachers. They are role models, consultants, problem solvers, and supporters. They provide timely and constructive feedback, career guidance, professional contacts, [are] sources of information about research grants and fellowship and job opportunities, and letters of recommendation throughout your professional career.*

5. Mentoring the Student

We have divided some thoughts on mentoring the student during the research project and thesis writing into three natural stages – the beginning, middle, and end.

A. The Beginning

With the mentoring relationship established, it is time to get to work. It is important that the student learns to be efficient and results-driven. Although long hours are normal, it is important to help the student realize that long hours are not a euphemism for success. As John Wooden, the famed college basketball coach, said, "Never mistake activity for achievement." Help the student understand the end game as soon as the project begins to be defined:

- "For the project sponsor, you'll develop a model that…"
- "You'll write a paper on…"
- "These results will help you in your future career because…"

At the outset, students should be given the expectation to prepare high-quality journal manuscripts as part of their graduation requirements.

Despite the new faculty's best efforts, a mentoring reboot several weeks into the program is often necessary. Why? The management style has not worked with too little or too much contact, the student misjudged course time commitments and has not devoted sufficient time to research, or the advisor was not sufficiently clear on goals and expectations at the beginning. At a mid-semester discussion of progress made, obstacles encountered, and overall status, the advisor could carefully invite feedback on the management style. Often, the objectives need to be made more specific and, sometimes, the project goals can be adapted to leverage student strengths. A student who is especially strong mathematically may be motivated more by a project with a theoretical bent, whereas other students may benefit from a more hands-on, experiment problem. This is not to say that the student should not be encouraged to become

stronger in an area of weakness, simply that leveraging strengths can build confidence, motivate a student to work especially hard, and result in overall productivity gains.

At the beginning stages, it is important to establish reasonable, but ambitious, goals that can be clearly related to the overall project objectives and milestones. These goals can then be directly tied to regular evaluations to determine whether the student is making satisfactory progress. If the student has the expectation from the outset that unsatisfactory progress toward these goals may necessitate reduced or suspended funding or eventual termination from the program, potential for surprises or frustration is reduced. Although our individual approaches vary, we have found that students rarely accomplish more than 3-4 major goals each semester when carrying a course load. The number of goals is adapted if a student is a teaching assistant or, for example, during the summer when they are usually focused on research full-time. Assigning specific deadlines to the goals will help students stay on task. Effective goals may be expected to take a couple to several weeks to accomplish and usually involve answering specific research questions, overcoming an obstacle, or writing, such as submitting an abstract to a meeting or producing a prospectus or manuscript draft. Although not all goals need to be accomplished serially, we caution against having a student pursue more than two goals simultaneously.

We have found that the SMART[5] approach to dividing the project (and thesis) objectives into milestones and shorter-term goals works fairly well if we remind ourselves frequently of the principles. Goals should be:

- **S**pecific
- **M**easurable
- **A**chievable
- **R**esults-focused
- **T**ime-bound

Additional principles may help the mentor and mentee smoothly make progress early on. We have, unfortunately, made the mistake of being so anxious to achieve results with a new student that the student becomes driven simply by short-term tasks outlined in weekly meetings, rather than gaining ownership of the project. This becomes particularly evident when it comes time to write a prospectus, a requirement of our department that generally occurs sometime during months 6-9 of a master's program and during years 1 and 2 of a doctoral program. If the student has not owned the project at or by that point, it is evident in their lack of understanding of the literature and how their efforts, thus far, tie to the broader picture. Dr. Greg Swift, a thermoacoustician at Los Alamos National Laboratory, frequently reminds participants of the biennial Physical Acoustics Summer School that "six months in the laboratory can save you a day in the library." Consequently, regarding literature searches, we suggest that students:

- Begin a thorough literature search as soon as possible following admission into the research program.
- Summarize key aspects of the most pertinent papers. Summaries can be used later in thesis/manuscript introductions.
- Become thoroughly familiar with the literature to ensure that they are significantly building on past work and becoming experts in the associated field.

- Continue the literature search throughout the research and writing process. A better understanding of additional search terms may uncover historical literature or related work may be published while the research project is being carried out.

To help the student organize and internalize their project objectives, a prospectus is helpful. Although not required for all programs, the principles may be helpful in allowing the student to make timely progress. We suggest that as early as possible, the students prepare a prospectus that includes clear objectives and milestones and, perhaps most importantly, a Gantt or similar chart so that they can gauge the required progress for timely completion of the thesis. The chart should be reviewed regularly during the thesis experience – too often students defend a prospectus that is signed and then essentially forgotten.

B. The middle

Regular research meetings, semester evaluations, and consistent progress in writing will help maintain a productive mentoring relationship. First, a student's research progress is monitored through regular research meetings. These are usually weekly, in our case, but can be more frequent if a deadline is approaching or if the student's progress warrants it. Research meetings could contain the following:

- Explanation of results, placed in context with literature
- Description of challenges being faced
- Review of the prospectus timeline

Something that often happens in regular research meetings is that the advisor spends a great deal of time talking as he or she outlines what needs to happen next and why. We have learned, through multiple experiences, that when this occurs, the advisor and student have often not effectively communicated – the student rarely understands all the advisor is saying and is sometimes reluctant to ask questions. Therefore, it is imperative that during research discussions, the students are asked to summarize explain what they are going to do next to ensure they understand the goal and how it fits in with broader milestones and thesis objectives. In addition to ensuring the advisor and student are communicating on the required steps in the research process, it gives the student practice in communicating technically.

These regular research meetings are also a time for encouragement and affirmation. Too often we, as mentors, take an approach to evaluating student work that we become accustomed to through the peer review process – we ignore too many of the positive aspects and only point out the shortcomings. Students need to walk away mentally prepared and motivated to work through issues and overcome obstacles in an excellent way. During the panel discussion that followed this session, Professor Anthony Atchley, Associate Dean in the College of Engineering at Penn State, said the following: "In research, you only succeed once because, after you've got it, you move on. You spend most of your time failing." Motivated students that are inexperienced with in-depth research may be unaccustomed to frequent failure and may become discouraged. In this light, a mentor is more than an advisor; he becomes a coach – set high expectations, but deliver praise whenever possible.

The new faculty member's mentoring efforts serve as a model for the graduate student as he or she becomes a peer mentor. The role of undergraduates in research varies across institution and discipline, but within the Acoustics Research Group at Brigham Young University, undergraduates are expected to contribute meaningfully to research programs. As they are beginning, they normally assist a graduate student or advanced undergraduate student with their research. The peer mentoring relationship has at least the following benefits:

- Undergraduates can become accustomed to working in the same sort of results-driven environment.
- Undergraduates can contribute meaningfully to research and potentially become an author on a publication.
- The graduate student develops personnel management skills, particularly when feedback is received by the faculty mentor. Often, the advanced student does too much initially for the undergraduate out of a desire to be helpful.
- Research productivity increases. Do not expect large increases in productivity in most cases, but real gains can be achieved.
- Knowledge can be shared among the students, reducing demand on the new faculty member's time. During the panel discussion, Professor David Bradley of Vassar College indicated that both he and his students benefited greatly from measurement protocol documents that had been created for room acoustics measurements. Not only did the students have a clearly outlined process, it saved him from having to explain the process to each student that entered his lab.

An essential component of a graduate student's success is learning to communicate technically both in oral and written form. It is essential that the mentor requires the student to begin writing early, through the prospectus and literature summaries, and then to continue writing throughout the degree process. We have found success in having students contribute meaningfully to sponsor progress reports and using that writing as an initial draft or outline toward theses and papers. Students become much more deeply ingrained in the research questions and processes as they begin to write about them. As Flannery O'Connor stated, "I write because I don't know what I think until I read what I have to say."

Students (and even experienced faculty members!) frequently underestimate the amount of time required to write. Students rarely believe, despite being told up front, that the first draft of a manuscript will usually be thrown out and that it is easier to begin anew. They also need to learn to pay attention to the author's voice, paper organization, and progression of ideas while reading technical articles. Careful observation will help them become better writers. Furthermore, as the faculty member encourages students to read books or articles on writing, such as "The Science of Scientific Writing,"[6] recommended by Professor Jay Maynard of Penn State during the panel discussion, the student begins to think more critically about his writing.

A difficult aspect of mentoring students in writing is providing meaningful feedback without completely rewriting the document for the student. Although there is no one way to write well, we have some suggestions that may help this process. First, if the first discussion of how to write well occurs after a draft of the thesis or journal manuscript is complete, it is too late. It is difficult to break down a lengthy document and start over. Discussions need to take place early on, covering one section, or one page, or one paragraph. In addition:

- During his talk in the special session, Professor Rich Raspet of the University of Mississippi, quoted the late Hank Bass, who summed up writing a scientific paper with, "Tell a good story." We find that if the mentor and advisor agree on the story (the reason for writing the paper, the contribution it makes, and the flow of ideas), the rest of the writing process is expedited.
- After the student develops first an outline that describes the "story," he or she develops it into an extended outline that contains all figures, captions, references, along with key sentences, conclusions, and transitional sentences between paragraphs. This helps the

advisor and student examine the ideas and document elements before proceeding to the full document.

- As an advisor, try to avoid focusing on spelling, grammar, and awkward sentences while the ideas and structure are being examined. There are many resources[7,8] available to help a new faculty member become an effective and efficient editor.
- Wherever possible, try to organize a thesis to minimize rewriting for conference papers and journal manuscripts. A new faculty member at a research institution needs to minimize the amount of time spent writing and editing that will not result in publications.
- Do not despair. It takes time and effort but, mentoring a student in writing about research as early as possible will pay enormous dividends in the end as subsequent writing requires less editing and the student finds a more professional writing style.

The final principle is carrying out regular evaluations of student progress by the advisor and, when possible, with other members of the student's graduate committee. In the Department of Physics and Astronomy at Brigham Young University, semester evaluations are a time to review academic progress, review progress made toward major semester goals and thesis milestones, and set new goals (see the prior discussion about setting SMART goals). Hopefully, everything is progressing well on the research front because of effective weekly meetings; but, what if the major semester goals are not being met and the thesis or project milestone completion is delayed? These are not easy, but are necessary, conversations to have with students. Some suggestions for these meetings are:

- If expectations for satisfactory progress are laid out in the beginning of the degree program and reiterated each semester when goals are set, critical feedback is easier.
- Invite self-evaluation by the student, including an accounting of time management. Again, recall the statement by John Wooden regarding activity versus achievement.
- Remind students that project accountability and completion is required for graduation, rather than simply "doing their time." They need to understand that being results and deadline-focused while performing excellent work has a huge impact on their employability, and that their progress is critical for the mentor to be able to provide a positive reference when the job search begins.
- As a mentor, be prepared to hold students accountable if they are not progressing. Funding or continuing-enrollment consequences for inaction are appropriate. Again, if the expectations are clearly communicated at the outset, the conversation is easier to initiate. At Brigham Young University, graduate students earning an unsatisfactory rating receive a letter with an advisor-produced plan outlining the things they need to do in the coming semester to regain a satisfactory rating status. If the progress during the next semester is not satisfactory, a student is dismissed from the program.
- Above all, help the student realize that evaluations, while sometimes difficult, are intended to help him or her reach the expectations laid out in the beginning and graduate in a timely fashion. Try to help the process be a constructive one, despite any personal frustrations encountered.

C. The End Game

Frustration occurs when the student and advisor do not communicate early on about an expected graduation date. We have students that begin applying for jobs relatively early and are faced with a conundrum when they receive a desirable job offer well before their thesis is complete. When the Gantt chart containing the milestones and schedule are reviewed regularly, it is easy to ask the student when he or she feels the prospectus milestones will be met. We recognize that some adaptation of goals may be necessary when significantly more time than planned is ultimately spent on one part of the project. However, regular discussions about the schedule and thesis objectives will help with this. Six months prior to the student's planned graduation, we find it helpful to start working backwards. If the student wants to leave campus on a certain date, when does he need to defend? When do thesis drafts need to be completed? When do the remaining research milestones need to be met for that to occur? This helps students view their progress with specific deadlines in mind.

Allowing for sufficient time after the thesis defense is also important. Something we have been stressing of late in our program is that the student needs to allow for several weeks (we suggest at least six) in between the defense date and the time she plans to leave campus. Why? In addition to the thesis corrections and passing of institutional knowledge to the next student, we reiterate the expectation that the thesis will result in a journal manuscript. The moment the student leaves to begin a new program or a job, the likelihood of that manuscript being finished rapidly decreases with time. We have seen, and many of our former students will agree, that what can be done in one day on campus at the end of a degree program may take weeks to accomplish after leaving the program when the only allotted time is evenings and weekends. When the student defends just a few days before leaving, thesis corrections are often rushed and the journal manuscript is usually forgotten. As our mentoring has improved through timely communication regarding expectations for the "end game," we have seen the students rise to those expectations, resulting in greater overall productivity.

6. Concluding Discussion

At the special session where this talk was presented, we joked that this was a theoretical talk. We are still learning how to become more effective advisors and mentors, and some may correctly dispute some of our suggestions as they do not fit their situation or institution. However, we submit that taking the time to consider how one can work most effectively with students and motivate them to rise to their potential is time well spent for a new faculty member. We end with the following inspiring statement from Columbia University that reminds us that to take on the role of mentor is much more than being an advisor:

> *An advisor provides curricular advice. A mentor's responsibilities are far broader, including all facets of professional development. Effective mentors model professionalism, demystify the graduate school experience, and help their student enter the profession. Effective mentors' responsibilities don't end with graduation. They take a personal interest in their students' future and provide assistance and advice at crucial moments during the student's career.*

We recognize that meaningful, lasting mentoring is not only what helps build successful students and programs, it forms the lifeblood of a professional organization. The ongoing

mentoring by senior members of the Acoustical Society of America helps to make it such an outstanding, collegial professional organization.

Acknowledgments

In addition to gratitude for unflagging support from our department, college, and university in relation to our efforts to mentor students in research, we are thankful to those who have patiently mentored us. We also acknowledge the many students we have advised and their contributions, not only to acoustics, but also to improving us as mentors.

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