Laboratory Management Institute: A Model for the Professional Development of Scientists

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Abstract

The Laboratory Management Institute (LMI) at the University of California, Davis (UC Davis) was an experiment designed to enhance the leadership and management skills of researchers and thereby enhance the overall quality of the academic research enterprise. The educational programs that resulted provide examples of how research administrators can help academic research teams become more productive, quality-vigilant, compliant, and safe; make a more satisfying research workplace; mitigate institutional risk; and advance science and careers. The LMI delivered educational programs for researchers that were novel in pedagogy, including *LabAct* learning, which used actors to help researchers practice skills such as communication, innovation, leading teams, and managing resources; *LabScripts*, which were sample dialogs researchers used to practice communicating authentically and to build their confidence before initiating important discussions (courageous conversations) with others; *LabTrek*, team building exercises for practicing research management skills; and *LabCheck,* a novel learning assessment tool. One of the LMI educational programs developed for postdoctoral scholars and some of the curricula and pedagogies developed through the LMI are described, as well as the rationale and significance for providing professional development for researchers at the institutional level.

Keywords: Laboratory management, responsible conduct of research, education, leadership, actors, theatre, postdoctoral scholars, pedagogy, career development, ethics, research integrity, compliance, *LabAct* learning, scientific method

Introduction

While announcements of new scientific discoveries appear almost daily, there also are reminders that some discoveries, such as the cloning of human cells by Dr. Hwang Woo-Suk from South Korea, are fabricated (Wade & Sang-Hun, 2006). Accusations of research misconduct are costly to an institution's recruitment, enrollment, funding and reputation. Increasingly, multiple million-dollar fines are levied by the federal government against universities for misuse of grant monies. Of the more than $200 billion invested in research annually in the United States (U.S.), the collective and less egregious errors and inefficiencies of scientists cost millions of dollars (Pascal, 1998). Excuses for research misconduct and inefficiencies include pressures to succeed, carelessness, poor recordkeeping, a breakdown of the peer-review system, lack of oversight of laboratory personnel, and the confusion and misunderstandings that sometimes can occur among personnel with diverse backgrounds or value systems. These rationalizations aside, misconduct and inefficiencies lie ultimately in the character and abilities of the individual researcher. Fortunately, leadership and management skills and, to an extent, integrity can be learned, but do researchers seek out and have time for this education, and do institutions have the necessary educational resources available for this learning to occur? The Laboratory Management Institute (LMI) was created to develop and use new educational resources to motivate researchers to acquire greater knowledge, abilities, and skills for establishing and managing their programs responsibly and efficiently.

1. Rationale

Research administrators have a broadly defined responsibility to ensure that the institutional culture promotes and facilitates excellence in the conduct of research. Through federally mandated committees such as the Institutional Review Board (IRB) and Institutional Animal

Care and Use Committee (IACUC), and through campus administrative units such as Environmental Health and Safety, research administrators approve and monitor the practices of researchers to help assure they comply with regulations governing the study of humans and vertebrate animals, as well as environmental protection. Through pre- and post-award services, research administrators help ensure the fiduciary responsibilities of the university and its personnel. Personnel involved in research funded by certain federal agencies now are required to receive education in the responsible conduct of research. Frequently, this responsibility also is being met by research offices. In the Office of Research at UC Davis, an experiment was conducted to expand the scope of education in responsible conduct of research to include laboratory management.

Protecting the Research Enterprise: Multiple Reasons for Providing Education in Scientific Management

While graduate students and postdoctoral scholars are likely to receive excellent education in their research discipline, they are less likely to receive formal education in the leadership and management skills essential for the day-to-day operation of a research program and laboratory (Pascal, 1998). Currently, academic institutions have invested limited resources in leadership and management education for graduate students and scholars because they expect this education to be provided adequately and equitably by faculty mentors. However, many mentors view such education as secondary to guiding the students' or scholars' research project. In addition, mentors sometimes lack education in management skills themselves, or the resources to teach the skills consistently and efficiently to their students and scholars. Also, they may lack experience to guide their students and scholars in developing professional skills for employment positions outside academia. A simple scan of advertisements for research positions will reveal that employers prefer applicants with good communication skills and an ability to work well within diverse teams. These and other highly desirable skills, such as problem solving, innovating, behaving with integrity, using best practices, and leading and managing research teams, are seldom taught formally in our universities, and no one mentor should be expected to meet all the various needs of his or her mentees.

Faculty researchers often have little or no education in managing laboratories with highly diverse people, but rely increasingly on the research work of international students and scholars. At the extreme, students from countries that have been battling over politics or religion for hundreds of years may be asked to work alongside one another. Educational programs are needed to develop the professional skill-set that enables scientists to overcome cultural, language, gender-orientation, ethnic, age, and other barriers to communication that can be encountered in a laboratory with a diversity of people. Studies have shown that, for complex tasks, a diverse team of skilled workers will outperform a homogeneous group of comparatively skilled and motivated workers if the diversity is managed effectively (Hayles & Russell, 1997).

There is growing need for researchers to mount rapid and highly collaborative and coordinated research responses to global crises. Translational and other collaborative research is becoming more important in a society that also is becoming more complex and global. Therefore, educational programs are needed for researchers to develop skills for leading and participating in research that is highly collaborative.

A skeptical public requires greater assurances of the believability and significance of research results to help them decipher and resolve what often appear to be contradictory results among researchers. The evidence must be as irrefutable as possible so that the public can determine if the scientist's inferences drawn from the research warrant changes in their own personal behavior, level of advocacy for certain lines of research, or their financial support of those research lines through taxes, grants, contracts, commercialization, and gifts. Scientists have an obligation to learn, use, and advance "best" scientific practices and perhaps a growing need to follow strictly, for instance, the guidelines of the Good Laboratory Practices Act. This creates an opportunity for research administrators to help researchers enhance their understanding of the importance of documenting the quality and validity of research results, and to provide greater institutional resources for enabling increased documentation. The increasing complexity of research and the increasing costs and volume of research data further require many researchers to be better trained in efficient execution of their research (Kulakowski & Chronister, 2006). Of equal importance, researchers with good leadership and management skills, such as an ability to communicate to the public how their research fits into a larger context, will be better able to acquire support. Research administrators can have a vital role in creating the means to assist researchers in these endeavors, and in providing career-enhancing educational programs to help them meet the growing need to compete for and leverage resources. For instance, research administrators might better enhance the education of researchers in the protection, licensing, and commercialization of intellectual property, in part, because of its significance as a source of funding or revenue.

Development of leadership and management skills is essential for decreasing the costs of mismanagement, research inefficiencies, and incidents of misconduct. More importantly, these same skills can increase scientific discovery, innovation, mentoring, and global competitiveness. A recent national survey reports that scientists spend, on average, 42% of their time on administrative matters (Keen, 2006) – time that otherwise might be used for discovery and innovation. Programs supported by research administrators that would help their faculty in mentoring students and scholars might increase scholarship.

More funding agencies are investigating allegations of scientific misconduct. The U.S. Department of Health and Human Services (DHHS) established the Office of Research Integrity (ORI) to investigate allegations of misconduct of scientists funded by the National Institutes of Health (NIH). ORI requires recipient institutions to have a means of investigating allegations of research misconduct in collaboration with the agency, and for submitting the results of their investigations to the agency for review, further investigation, and judgment. Research administrators, through preventive educational programs, can lessen these costs.

NIH and other funding agencies require applicants to have education in responsible research to be eligible for certain awards. Applications for specific NIH funding programs must include documentation about how investigators have or will have met education requirements in the responsible conduct of research, including data acquisition, management, sharing, and ownership; conflict of interest and commitment; collaborative science; human and vertebrate animal subjects; publication practices, responsible authorship, and peer review; and mentor and trainee responsibilities. Investigators and institutions not meeting the education requirements can lose funding.

Finally, the research enterprise is enhanced if researchers help reduce IRB and IACUC operating costs by submitting and effectively executing study designs that will accomplish their research goals while posing fewer compliance problems and requiring less review and monitoring.

Almost all institutions have departments of human resources that provide developmental education for faculty and staff, but these educational opportunities usually are not designed to address the specific needs of researchers, as described above, nor are they utilized widely by researchers.

The academic research enterprise could be enhanced and protected effectively and efficiently through institutional education programs for researcher development such as those developed by the LMI.

2. Significance

Described here is a new model for institutional mentoring of students and scholars that is equitable, accountable, and provides greater assurances of their employability. The intended outcome was a change in the culture of mentoring students and scholars to provide learning opportunities at the institutional level, while at the same time highlighting for research administrators the importance of laboratory leadership and management education to a university's research enterprise. The program described was not only a response to growing education requirements by funding agencies, but also designed to explore the extent to which research offices have responsibilities, perhaps obligations, to faculty, students, scholars, and staff for consistent and equitable access to educational opportunities and experiences for their professional development. The program expanded on existing curricula for responsible research education, to include education in the daily operations of research, because research integrity also requires scientists to be good stewards of the resources provided to them.

The LMI's program for postdoctoral scholars included education in best practices, research compliance, stewardship, communication, collaboration, problem solving, and mentoring. The program was designed to help support mentors' efforts to provide the best possible education for their postdoctoral scholars with a minimal time commitment. Ultimately, the education was expected to decrease costs of mismanagement and incidents of misconduct, increase science and engineering discovery and innovation, and make careers in science more satisfying and fulfilling.

The program was designed to give postdoctoral scholars a jump start into their research project while at the university and into their careers once they left. With more than 2200 laboratories, 3000 international students, and a highly diverse population of graduate students and postdoctoral scholars, UC Davis was an ideal location for initiating such a program.

3. Program Background and Steps of Program Development

In 2003 a committee appointed by the Provost and chaired by the Associate Vice Chancellor for Research, assessed risks to research compliance at UC Davis. A group from this committee conducted a survey of campus laboratories that revealed a need for educational programs to help scientists gain skills in managing and understanding people, budgets, and regulatory and compliance issues (Pascoe, et al., 2003).

In 2005, Howard Hughes Medical Institute (HHMI) and Burroughs Wellcome Fund (BWF) awarded UC Davis and 19 other institutions grants to participate in their "Partners in Scientific Management Program" to teach others how to teach courses in scientific management. The HHMI/BWF partners program grew out of a 2002 workshop at the HHMI campus, where approximately 100 junior scientists learned about scientific management to help jump-start their careers (BWF/HHMI, 2004). In 2005, HHMI and BWF offered the workshop for a second and last time to another group of approximately 100 junior scientists, in part, to provide the 20 partners with the materials and experience to propagate the instruction at their respective institutions. Although HHMI/BWF provided funding for the partners to participate in and observe the workshop, each institution was responsible for providing and funding similar workshops at its respective site before the end of 2007.

To meet this obligation, and recognizing the value of providing laboratory management education, the Office of Research and six of the campus Dean's offices contributed funds for the UC Davis program. The LMI was established in July 2005, and its Director was charged with both developing an annual, year-long program for postdoctoral scholars, and thinking programmatically to enhance the missions of the university and lead the way for other institutions. What developed included education beyond the initial targeted group of postdoctoral scholars and beyond the minimal regulatory requirements provided through traditional seminar series and on-line training. Some of the goals of the LMI included filling an education gap, meeting the University's responsibility to train and mentor, helping jump-start and advance careers, enhancing skills in laboratory research, meeting a perceived national and international training need, enhancing regulatory compliance, reducing risks of penalties and litigation costs, achieving greater research efficiencies, aiding recruitment and retention, and enhancing science and the work environment.

The LMI was envisioned as a national and international resource for researchers and research administrators. Its mission was to provide comprehensive leadership and management education to help ensure research productivity and quality while enhancing the safety and well being of laboratory subjects and personnel. The activities of the LMI were to develop, validate, deliver, evaluate, and disseminate new curricula that would help researchers obtain, through didactics and practice, the leadership and management skills they would need to be effectual and innovative in their chosen professions.

The formation of the LMI, and the availability of a competitive award program for postdoctoral scholars, was announced at a campus-wide seminar. Making the program competitive gave awardees, their mentors, and their College or School additional stature and, therefore, incentive to apply. A unique aspect of the seminar was the inclusion of a performance by two acting students from the UC Davis Theatre and Dance Department, who played the roles of a postdoctoral scholar and graduate student working at a laboratory bench. The scene illustrated the need for laboratory management education in a realistic, humorous, and sometimes egregious way, and drew immediate interest in the program. The success of the theatrical performance resulted in articles in campus newspapers about LMI. A logo was created for LMI to enhance brand recognition, and an LMI website was established through which scholars could apply to participate in the program. A committee evaluated and selected the awardees from the pool of applicants.

4. Program Description

Program

For the initial LMI education program, 22 postdoctoral scholars were selected from more than 30 nominated by their mentors, representing the schools of Medicine and Veterinary Medicine, and the colleges of Agricultural and Environmental Science, Biosciences, Engineering, and Letters and Science. Each year the number of postdoctoral applications and awardees increased (to 24 then to 26).

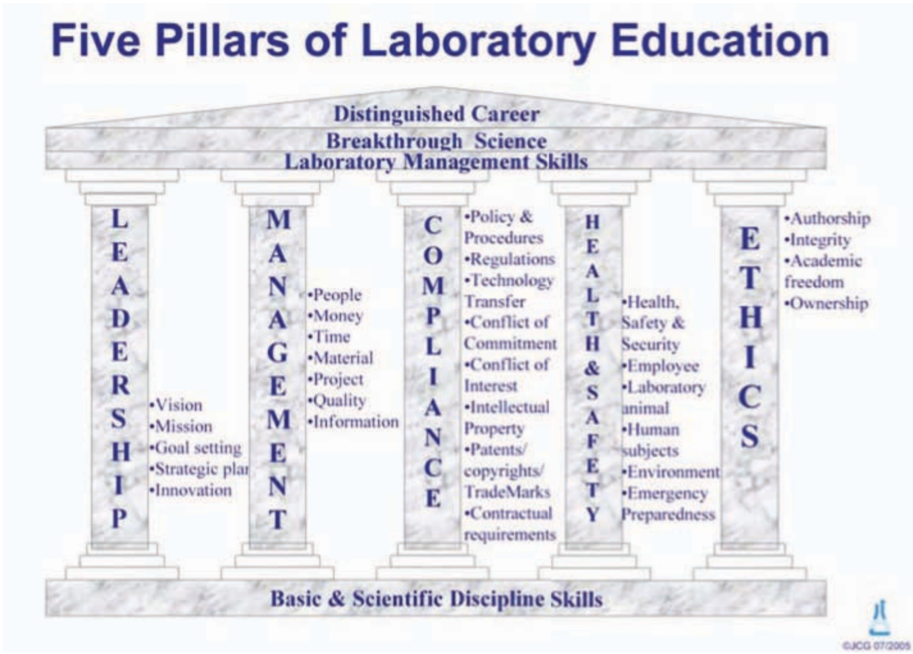
Postdoctoral scholars were the initial target group of researchers for receiving the LMI education because they often manage the day-to-day activities of academic research laboratories. In addition, they interact frequently with graduate and undergraduate students, technicians, institutional support staff, and their mentors. Therefore, the dissemination of education to postdoctoral scholars assumed a domino effect throughout the campus. Applicants were selected primarily on how they proposed to transfer what they would learn to other members of their laboratory and department. One postdoctoral scholar stated: “The LMI program is not about training 20-some postdoctoral scholars each year; it is about training more than 20 laboratories each year.”

The program format was a two-day workshop followed by 12 monthly, two-hour evening sessions that focused on selected topics in depth. These closed sessions were confidential so the scholars could speak freely about their experiences. One of the authors (JCG) made four-hour visits to each scholar’s laboratory for one-on-one learning and discussion outside the group sessions, and became for many of the scholars a confidante and mentor. Collaborative and social networks were formed during the program and have continued among some of the scholars.

Curriculum

The LMI curriculum for postdoctoral scholars was designed to build on their basic and scientific discipline skills, to include developing skills in leadership, management, compliance, health and safety, and ethics (Figure 1).

Figure 1
Laboratory Management Institute Five Pillars of Laboratory Education.



Several curricular themes emphasized (a) research professionalism and adherence to ethical principles, (b) stewardship of research resources, (c) self-assessment and improvement, (d) interpersonal and communication skills, (e) building working relationships with essential research support partners, (f) discovery and innovation, (g) mentoring and being mentored, and (h) placing research into a larger context.

Theme Teams

More than 30 UC Davis staff and faculty members agreed to make presentations during the two-day workshop. They met in small "theme teams" (e.g., health and safety, compliance, budget preparation and funds management) to discuss and coordinate their presentations. Health and safety topics included personnel roles and responsibilities, authorizations for research involving hazardous materials, and injury/illness prevention planning. Compliance topics included the work of IRBs and IACUCs, good practices guidelines, standard operating procedures, and responsible conduct of research (ethics and integrity). The budget preparation and funds management team discussed direct and indirect costs, authorization of expenditures, and changing budget allocations.

The curriculum drew, in part, on the BWF/HHMI (2004) guide, programs such as the University of Pittsburgh's "Survival Skills and Ethics Program," presentations by The Center for the Health Professions at UC San Francisco, articles in *Science Next Wave*, and *Naturejobs*, texts by Barker (2002), Sapienza (2004), Macrina (2005), and Cohen and Cohen (2005), and the extensive business leadership and management literature.

Unique Pedagogy

The LMI developed innovative education methods, such as *LabAct* learning, *LabScripts*, and *LabTrek,* which gave learners practice in developing professional skills in research. Practicing can be as essential to the scientist running a laboratory as it is to a musician preparing for a performance. Practicing leadership and management skills actively reinforces what one learns through less active means such as reading, listening, or even interacting with computer video.

LabAct Learning

LabAct learning allows participants to practice problem-solving solutions to real-life issues they face in their laboratories (Table 1), including personnel conflict, negotiating authorship, or complying with fiduciary or research regulations. *LabAct* learning is itself a laboratory in which participants use the scientific method to increase their problem-solving knowledge and skills. What is unique to *LabAct* learning, and what is appealing to researchers, is that the learning is based in the scientific method — hypotheses are tested, assumptions specified, controlled experiments performed, data collected, analyses made, and inferences drawn to help develop skills in running a research program.

LabAct learning uses a facilitator (*LabAct*ivator) and specialists who are professional actors (*LabAct*ors) to help participants experiment with multiple resolutions to issues that can arise in the research workplace. In this way, *LabAct* learning is a simulator for participants to learn important professional skills by practicing them in a safe, supportive environment before using them in real life. What separates *LabAct* learning from other education strategies is that the participants, not the leaders, define the issues and evaluate the success or failure of solutions they derive.

Step 1: Confidentiality.

The *LabAct*ivator first emphasizes the importance of confidentiality and respect in the *LabAct* learning laboratory so that participants feel they can speak openly about the issues.

Step 2: Identifying the issues.

The *LabAct*ivator asks participants to write about an issue they are facing or expect to face in their own laboratories, describing a specific situation in which the issue is raised, the organizational roles within the laboratory of the people involved and their relationship to one another, and any other information that would help clarify the issue. No information is used that might identify the specific people or location, and participants do not identify themselves as the author of the issue. Thus, *LabAct* learning is a blinded study. The *LabAct*ors then separate those issues that are unique from those that are common. They list these on a flip chart so each has an equal chance of selection for experimentation. The *LabAct*ivator simultaneously makes a brief presentation on such topics as the scientific method, teamwork, celebrating diversity, and changing outcomes by changing one’s own attitudes, perceptions, and behavior.

Step 3: Selecting the issues for experimentation.

After the presentation, participants are shown the list of issues (referenced earlier in Table 1) and select those most useful to investigate with the scientific method. Once several key issues are selected, the *LabActi*vator and *LabAct*ors solicit more specific information regarding the characters, setting, and circumstance. This important step gets the participants involved and, more importantly, provides reference points that help the *LabAct*ors make the experiment relevant and realistic.

Step 4: Portrayal of an issue.

The *LabAct*ors improvise the scene, illustrating the issue often in an egregious or humorous way, which helps define it and make it memorable. If the scene does not "ring true," refinements are made until it does.

Usually a scene involves two characters with opposing points of view, goals, principles, values, desires, expectations, personalities, compatibilities, or resources. The participants can experiment with the behavior of one character (the experimental person) but not with the other (a quasi-control). Usually, participants identify with the character whose behavior they will manipulate. The control is the real or perceived source of conflict — the character who hinders, blocks, counteracts, interferes, or prevents expression of the experimental character's morals or values (ethical conflict), or keeps him from reaching his goals. The behavior of the control can be influenced only by the behavior of the experimental character. The source of conflict need not be another person, but can be part of the physical, cultural, or social environment, or a destructive element in the individual's own nature (inner conflict).

In general, the scenes contain more than one point of conflict among the characters, but one underlying cause, which until enacted may be difficult to uncover. Often, the conflict among the characters results in tension, anxiety, fear, anger, and other emotional responses that the participants and *LabAct*ors comment on immediately after the scene. These comments contribute significantly to the instruction.

Step 5: Discussion of portrayal and suggested resolutions.

After the scene, the *LabActi*vator invites comments and responses from the participants, and gathers their suggestions on different ways that the conflict might have been prevented, minimized, or resolved. Participants also are invited to specify any underlying assumptions they perceived the experimental character to be making that contributed to the conflict. Keywords from the discussion are written on a flip chart to label each potential resolution suggested.

Step 6: Resolution experimentation.

Using information from the discussion, the participants select one of the potential resolutions. The *LabAct*ors reenact the scene, but this time the experimental character uses the participants' suggestions to try to alter the response of the control. Following the scene, a discussion led by the *LabActi*vator ensues to collect the opinions of the participants about what was or was not successful. The *LabAct*ivator is careful not to bias or lead the discussion to a certain conclusion. All resolutions have the potential of working; participants judge them on their face value and what they perceive would work for them if they were having a similar conflict. The scene is replayed as long as time and potential resolutions allow.

Step 7: Participants as actors.

As participants gain confidence, they are invited to demonstrate ways to resolve issues themselves. This results in *embodied learning* (Fuller, et al., 2005), as participants experiment with changing their own behavior and determine for themselves if those changes are effectual and resonate with their sense of self. Thus, the group helps foster critical thinking and collective analysis of shared problems.

The *LabAct* learning sessions often are videotaped for subsequent use so the participants can see and, if necessary, modify future behavior. The videotapes also are used for other courses, on-line instruction, and demonstrations of the pedagogy. Participants are encouraged to record in writing what they have learned about themselves and others, and how they will prevent, minimize, or resolve a particular problem, conflict, or issue they are facing in their laboratory. From *LabAct* learning sessions, useful data are gathered for academic institutions, industries, and government regarding the kinds of issues next-generation researchers face in their academic laboratories, as well as an array of prevention and resolution strategies.

Step 8: Inferences.

At the conclusion of a *LabAct* learning session, the *LabAct*ivator asks the participants to identify those communication principles that might be applied to their own situations.

Benefits of *LabAct* Learning

LabAct learning experimentation provides an educational experience for learners to clarify and examine problems or issues pertinent to them, and can facilitate their insight, personal growth, and positive behavioral changes. *LabAct* learning experimentation shifts abstract concepts, such as integrity, into a simulated, lived experience, which allows the participants to observe or enact interpersonal conflict, witness or experience the success or failure of conflict resolutions, and determine which resolutions resonate best with their own personality. *LabAct* learning experimentation tests the hypothesis that changing another's attitude, perceptions, and behavior comes primarily from changing one's own. Many of the *LabAct* learning scenarios, although specific to a particular circumstance, become relevant on a broader level as issues of accountability, trust, choosing one's battles, being clear in communication, and other themes.

Plays have long been used by educators to convey concepts and teach behavior. However, with these forms of theatre, students are passive recipients and not active producers of the actions or topics to be enacted. *LabAct* learning experimentation is a new way of using the theatre arts, derived from other theatrical structures such as Forum Theatre (Boal, 1998), Playback Theatre (Fox & Dauber, 1999), and Psychodrama (Moreno, 1983).

Among other critical professional skills, *LabAct* learning sessions are a tool for modeling, identifying, discussing, and practicing individual, dyadic, and group communication skills, styles, and behaviors, and for analyzing communication within and across cultures, languages, dialects, and genders. Problems, disputes, misunderstandings, impasses, and conflicts among and between people and groups so often result from differences in communication skills, styles, and behaviors. *LabAct* learning sessions model verbal and nonverbal communication skills and behaviors that can make or break a communicator's message. These include word choice, thought organization, tone, voice speed, delivery, turn-taking in conversation, proper pronunciation, dialect and language use and active listening, eye contact, leaning in, open or closed body posture, nodding, position of listener relative to speaker, shared attentiveness to listeners and receivers of message. The roles of these critical communication elements are played out, analyzed and discussed.

LabScripts

From some of the issues and resolutions identified through *LabAct* learning experimentation (Table 1), program participants constructed scripts (*LabScripts*) to practice initiating discussion with their coworkers or mentors. *LabScripts* about topics that can be uncomfortable to discuss are used as examples for initiating what LMI called "courageous conversations." Courageous conversations on these and other topics can be especially difficult for students and scholars from differing cultures. Yet, in the culture of science, not speaking up can jeopardize the integrity of the research as well as important functional relationships in the laboratory. Later we discovered best selling books about these kinds of conversations with such titles as "Lifescripts" (Pollan & Levine 1996, 1999, 2004), "Crucial Conversations" (Patterson, et al., 2002), and "Fierce Conversations" (Scott, 2002, 2004).

LabTrek

The LMI used a project-management learning exercise conceived originally by Milton Datta (Emory University), with assistance from Martin Ionescu-Pioggia (BWF) and one of us (JCG). Briefly, it is an exercise in which a participant or team of participants can practice professional-development skills learned during LMI instruction. The object of the exercise is to choose one or more research hypotheses from a list that, upon testing, will provide preliminary data in support of a large grant to be submitted to a funding agency. Next, constrained by an operational budget, the participants must select from a list of experiments to perform and choose the necessary personnel to conduct the experiments successfully. During the exercise, unexpected but real events affect the outcome of these experiments as participants draw cards of misfortune and fortune. The repertoire of *LabTrek* exercises has expanded to include one in which participants practice developing a laboratory protocol.

In each of these practice activities, the learner obtains immediate feedback about the productivity, innovation, and discovery resulting from the quality of the interactions among the participants. As a result of these practice exercises, the learner builds self-confidence.

Table 1

Some Issues Raised and Addressed by Laboratory Management Program for Postdoctoral Scholars

Authorship, authorship, authorship
Squabbles over shared equipment
Dealing with administration
International female scholar afraid to approach mentor about her and husbandÕs desire to start a family
Male postdoctoral scholar from patriarchal society behavior toward females in laboratory
Ethnic, language, and cultural silos of individuals working within labs
Opportunities outside academia (on average only 9% of postdoctoral scholars receive academic appointments)
Technology transfer and patent issues (proper documentation to facilitate patenting)
Mentoring of others in lab
Time management and follow-through
Achieving balance between work and oneÕs other life
Communication/ethical issues related to interdisciplinary and collaborative studies
Situation-appropriate behavior
Resolving differences between labs in their mentoring/procedures (the comparisons mentees make between their lab mentor and others)
Difficulty in juggling different goals of persons in lab
How much time can a mentor afford to invest in mentee? How much to get involved? When over-involved? Where to draw the line?
Dealing with constant changing of processes in lab; dealing with change
Criteria for success in academia/industry
Innovation and discovery
Awareness of oneÕs limitations and limitations imposed on them where they will be going
Supervision Ð how to do it; managing day-to-day activities in lab; dealing with the variety of people in the lab including visitors
How to hire and train personnel so they will fulfill their responsibilities
How to deal with protocol divergence
Personality issues Ð managing disruptive people
How to pick the right people Ð practical tips
Firing someone: how to do it; what documentation is needed? What rules/guides are there?
Meeting the needs and goals of mentee and mentor
How do you motivate (to have them do their work and meet deadlines)?
Improve efficiency Ð management style; differences between managing small v. larger labs
How to find and negotiate a job; career management
How to bring ideas for discussion and to resolve problems
How to become more independent, and an independent thinker
How to be candid, overcome shyness, or tone down the overtly gregarious

5. Program Assessment

LabCheck Observations

Using techniques published elsewhere (Goodger, et al., 1988), each of the postdoctoral scholars was interviewed, during four-hour walk-through visits of their mentor's laboratories, to record changes that occurred in their laboratories as a result of the education. These observations ranged from how participants developed standard operating procedures and signage for their labs to resolving complex issues related to diversity and life-work balance. Written anonymous comments and public comments by each of the three classes of postdoctoral scholars were almost unanimously positive; many gave the University permission to use their comments as testimonials.

The LMI curriculum and teaching method captured international recognition with a note in *Nature* (McCutcheon & Galland, 2006); a featured program in articles in *Science* (Aschwanden, 2007), *Cell* (Aschwanden, 2006), *The Scientist* (Grens, 2007), and *The Chronicle of Higher Education* (Brainard, 2006); and in an article published in the *POSTDOCket* newsletter of the National Postdoctoral Association (Galland & McCutcheon, 2006).

The accomplishments of LMI extended far beyond the annual postdoctoral program. During its three-year tenure, more than 1000 scientists, including more than 70 UC Davis postdoctoral scholars, participated in its educational programs. An annual 14-credit-hour Certificate Program in Scientific Management was developed which attracted scientists from as far away as West Africa. Also attending were representatives from the United States State Department, forensic laboratories, research hospitals, public health laboratories, national laboratories, and pharmaceutical companies. An annual day-long staff development course in laboratory management was initiated. LMI has provided workshops to various groups including undergraduate engineering students, both established and newly appointed medical school faculty, newly appointed faculty from multiple disciplines, research administrators, and veterinary degree students. A workshop in laboratory management was given to more than 300 international graduate students enrolling that year at UC Davis. Workshops in Laboratory Management were conducted at Harvard, UC Berkeley, The National Postdoctoral Scholars Association, Sigma Xi, Lawrence Livermore National Laboratories, Los Alamos National Laboratory, and Sandia National Laboratory. Two new graduate courses at UC Davis were developed, one in the Comparative Pathology Graduate Group for learning about managing biomedical research programs responsibly, and the other in the Department of Theatre and Dance for training *LabAct*ors. The Institute was awarded contracts to educate scientists from North Africa and to provide educational material to ORI.

Discussion

The LMI program for postdoctoral scholars did not come without opposition. Some faculty did not believe that they needed any institutional help in mentoring students. Some did not want to provide the release time for their postdoctoral scholars, or felt that the education would call into question their own practices. Some questioned the need for the expenditure of institutional funds and the quality of the instruction. Some expected their postdoctoral scholars to learn, as they had learned, in the *School of Hard Knocks*. Some questioned the need for adding to an already full curriculum, while others thought that teaching human development disparaged the prestige of the university and likened the program to what might be offered at career development schools. Some felt that career skills either cannot be taught, or are too discipline-specific to be taught broadly. Some resented the administration for intruding on academic affairs under the purview of the faculty, while others were indifferent, thereby impeding any groundswell of support. Indeed, some opinions were changed, particularly after faculty experienced the newly acquired skills and knowledge sets of their postdoctoral scholars. Most of these changes in faculty attitudes were noted anecdotally. A more systematic and scientific assessment would be a valuable addition to future studies of changing the perceptions and attitudes of faculty when implementing new institutional programs such as the one described here.

Conclusion

Not only must researchers solve scientific issues in the laboratory but also a myriad of managerial issues, which often can be more perplexing. Research administrators can strengthen the research enterprise by providing educational programs that develop the managerial skills of researchers that will better enable them to establish, manage, and sustain their independent and collaborative research programs effectively and responsibly. These educational programs can impart critical information and skills in a way that is appealing, engaging, and dynamic. Practicing managerial skills before exercising them builds learner confidence. Creating curricular themes helps organize and formalize a heretofore unstructured body of knowledge in leadership and management for researchers and provides a framework for future learning. Offering the education centrally makes it uniformly assessable and consistent.

Initiating educational programs to enhance the managerial skills of researchers at an academic institution requires buy-in from administrators who would be stakeholders in such programs (e.g., administrators of research compliance, health and safety, faculty and staff development, business schools, and graduate studies), from staff who would support the program administratively and help develop its content, and from those faculty members who are categorized generally as early adopters of new programs who would influence others to participate. At UC Davis, the LMI was created largely through a top-down approach, followed by a groundswell of support generated by the postdoctoral scholars and faculty mentors who participated in the LMI educational programs.

A key success of the LMI program was that it gave postdoctoral scholars, an often neglected but essential group to the academic research enterprise, a forum to share experiences and grow professionally. One postdoctoral scholar reflected that the time she spent in the LMI program would be added to her lifetime total of happy moments.

It can never be known completely the extent to which the most beneficial discoveries and important academic innovations can be delayed as a result of unintended suboptimal management skills in the research laboratory environment. One can never expect that any institution or any research laboratory will always be capable of exercising the most optimal forms of leadership. However, growth in laboratory management is always an important, ongoing goal requiring continual quality professional development. It is the hope of the authors that research administrators and educators will infer from the observations cited in this paper that they can reduce the risks of suboptimal management and promote the finest in laboratory leadership through actively enhancing the research skills of those involved in the research enterprise at their institutions.

References

Aschwanden, C. (2006). Learning to lead. *Cell, 125*, 407-409.

Aschwanden, C. (2007). Careers for postdoc scientists: Transferable skills and portable careers. *Science*, *316*, 471-475.

Barker, K. (2002). *At the helm: A laboratory navigator, updated version.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

Boal, A. (1998). *Legislative theater*. New York: Routledge.

Brainard, J. (2006, November 10). Universities experiment with classes in scientific ethics: Pilot programs tackle a difficult topic amid questions about such education's efficacy. *The Chronicle of Higher Education,* pp. A22-A23.

Cohen, C., & Cohen, S. (2005). *Lab dynamics: Management skills for scientists.* Cold Spring Harbor, NY**:** Cold Spring Harbor Press.

Fox, J., & Dauber, H. (Eds.). (1999). *Gathering voices: Essays on playback theatre*. New Paltz, NY: Tusitala Publishing.

Fuller, A., Hodkinson, H., Hodkinson, P., & Unwin, L. (2005). Learning as peripheral participation in communities of practice: A reassessment of key concepts in workplace learning. *British Educational Research Journal, 31*(1), ,49-68.

Galland, J. C., & McCutcheon, J. R. (2006). New institute provides research leadership and management education for postdoctoral scholars. National Postdoctoral Association *POSTDOCket, 4*(2):5.

Goodger, W. J., Repp, S., & Galland, J. C. (1988). Toward developing an instrument for measuring milking management practices. *Acta Vet Scand Suppl. 84*:129-32.

Grens, K. (2007). Dealing with conflict. *The Scientist, 21*(2):26.

Hayles, R. V., & Russell, *A. M.* (1997). *The diversity directive: Why some initiatives fail and what to do about it.* New York, NY: ASTD/American Society for Training and Development; Irwin Professional Pub., McGraw Hill.

Howard Hughes Medical Institute and Burroughs Wellcome Fund. (2004). *Making the right moves.* Chevy Chase, MD: Howard Hughes Medical Institute.

Kean, S. (2006, July 7). Scientists spend nearly half their time on administrative tasks, survey finds. *The Chronicle of Higher Education.*

Kulakowski, C. E., & Chronister, L. U. (2006). *Research administration & management*. Sudbury, MA: Jones & Bartlett.

Macrina, F. L. (2005). *Scientific integrity* (3rd ed.). Washington, DC: ASM Press.

McCutcheon, J., & Galland, J. C. (2006). Actors as teachers. *Nature, 440*(7081):252.

Moreno, J. L. (1983). *The theatre of spontaneity* (3rd Ed.). New York: Beacon House.

National Bioethics Advisory Commission. (2001). *Ethical and policy issues in research involving human participants***.** *Volume I: Report and recommendations of the National Bioethics Advisory Commission, August 2001. Bethesda, Maryland.* Retrieved April 24, 2007 from http://www.georgetown.edu/research/nrcbl/nbac/pubs.html

Pascal, C. (1998). *Management of biomedical research laboratories.* DHHS ORI Workshop, University of Arizona.

Pascoe, John et al. (2003). *Report of the sub-committee on research compliance*, University of California, Davis.

Patterson, K., Grenny, J., McMillan, R., & Switzler, A. (2002). *Crucial conversations: Tools for talking when stakes are high*. New York, NY: McGraw-Hill.

Pollan, S. M., &Levine, M. (2004). *Lifescripts*. Hoboken, NJ: Wiley.

Sapienza, A. M. (2004). *Managing scientists: Leadership strategies in scientific research* (2nd Ed.). Hoboken, NJ: Wiley-Lise, Inc.

Scott, S. (2004). *Fierce conversations: Achieving success at work and in life, one conversation at a time*. New York: : Berkeley trade paperback edition.

Wade, N. and Choe Sang-Hun. (2006, January 10). Researcher faked evidence of human cloning, Koreans report. *The NY Times*. Retrieved August 28, 2008 from http://www.nytimes.com