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Teaching Laboratory Rodent Research Techniques under the Tenets of Situated Learning Improves Student Confidence and Promotes Collaboration

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A targeted needs assessment at our institution revealed that the online system used to train researchers on performing techniques with animals did not provide opportunities to practice skills, introduce learners to animal care staff, nor satisfactorily support researchers' needs to become comfortable with laboratory animal species. To correct these deficiencies, a series of hands-on training sessions, framed theoretically in situated learning, was developed. This theoretical framework asserts that learning for everyday living (in this case, performing laboratory animal techniques) happens when people interact within the community while using the 'tools at hand' (that is, the instruments and jargon of the field). From this perspective, the students work alongside the instructor as apprentices. The instructor creates increasingly challenging learning opportunities as students work toward independently performing techniques. To test our hypothesis that teaching from this perspective improves comfort levels with laboratory animals and promotes collaborative relationships between animal care and research personnel, a mixed-method design involving online surveys (first survey, *n* = 45; second survey, *n* = 35) and semistructured interviews (*n* = 10) was used. Quantitative results revealed that students became more comfortable with laboratory animals and were more likely to contact animal care personnel due to participating in the training program. The qualitative arm of the study identified specific features of the training program that improved comfort levels for students (seeing then doing, working in small groups, learning within a comfortable environment, and building collegial relationships). These results support teaching rodent research techniques from the practical and theoretical approach of situated learning.

Our institution conducted an inhouse targeted needs assessment[10,15] in 2009 to evaluate the effectiveness of a commercially available online learning system that served as mandated training for personnel conducting research using animals. Although this online training met federal and institutional obligations to assure that all personnel are trained sufficiently to perform procedures using research animals,[1,2,10,14,22] the 'performance standard'[14] approach described in the Guide for the Care and Use of Laboratory Animals (*The Guide*) encourages institutions to establish "appropriate performance measures"[14] to determine whether goals are being met. To comply with *The Guide*, a combination of online surveys and focus-group interviews was used to determine whether the online format provided training that supported researchers' needs[10] and whether researchers were able to adequately perform techniques described in approved animal care and use protocols. Researchers reported that the information available in the online training system was valuable and conveniently accessed. However, there was an overrepresentation of personnel who specifically requested hands-on training to gain confidence with common skills and laboratory animal species. An additional concern that emerged during the needs-assessment process was that the online training did not adequately fulfill the spirit of the regulatory requirement to assure that "personnel conducting procedures on the species being maintained or studied will be appropriately qualified and trained in those procedures".[22] Although the computerized training allowed the opportunity to gain content knowledge about animal care and use, documented via successful completion of a multiple-choice assessment tool, the format did not provide the opportunity for researchers to learn in situ, practice, and physically demonstrate proficiency. There was not a valid means to assure the IACUC that researchers were qualified to perform specific animal care procedures.

In addition, the online training did not provide an opportunity to foster collegial relationships between researchers and animal care personnel, thereby decreasing the likelihood that researchers would draw on the expertise of qualified animal care personnel when assistance was needed and problems arose. A documented shortcoming of learning online, earning it the nickname "lonely learning,"[17] is that it may promote "participant isolation,"[3] a phenomenon whereby online class participants do not have contact with other students or faculty during the learning process. To address participant isolation; promote collegial relationship building between researchers, staff, and faculty; and respond to researchers' requests for opportunities to more directly engage and practice common animal research techniques, it was decided that a hands-on training program would benefit the institution.

Hands-on training that uses laboratory animals for skills building or increased understanding of complex processes has been shown to be beneficial to students in a variety of fields.[7,11,21,23,25] For example, medical students who participated in emergency-procedures training using deeply anesthetized domestic swine reported being more confident and better able to perform emergency techniques on humans.[22] In a similar study, groups of medical students who had hands-on training with resuscitative procedures by using a swine model were

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compared with students who watched a videotape of the same procedures.[11] The study found that while there was no difference in the number of complications for any group, the students who participated in the hands-on training were significantly more proficient and faster for 2 of 3 procedures performed.[25] In addition, physical therapy students who participated in a hands-on physiology laboratory using freshly euthanized frogs (*Rana sphenocephala*) reported that working with the animal model improved their understanding of physiologic concepts and better prepared them for examinations and clinical internships.[21] Finally, first-year veterinary students who participated in hands-on training for handling swine reported increased confidence and ability in a number of techniques.[7] Additional reported benefits of hands-on training using animal models include an increase in the students' sense of responsibility, the ability to visualize complex functional relationships, an increased understanding of the unpredictability of a living system and a greater "appreciation for the process of scientific inquiry."[21] The acknowledged limitations in hands-on training using animal models include the need for physical space, increased cost, requirements for trained faculty, and ethical concerns with using live animals for teaching.[11,21,23,25,26] Because our institution had a trained faculty member, shared space available for training, and evidence that researchers were requesting a more experiential format for animal care and use training, a hands-on training program was developed over the course of the 2009–2010 academic year and was implemented in August 2010.

The hands-on training program at our institution consists of a series of 8 training topics presented as 2- to 3-h sessions for practicing common concepts and techniques. Topics include rodent handling, rodent anesthesia, introduction to surgery, rodent colony management, advanced rat techniques, advanced mouse techniques, euthanasia techniques, and basic necropsy techniques. The content was chosen on the basis of results of focus-group interviews, input from the IACUC, regulatory requirements,[2] AALAS training materials, and published refinements of common techniques.[4,5,27] The goals of the training program were 3-fold: 1) to provide opportunities for researchers to become proficient at the procedures described in their animal care-and-use protocols before starting their projects; 2) to create a learning environment that promoted collaborative relationships between researchers and trainers so that researchers would feel comfortable seeking out trainers for help; and 3) to provide opportunities for researchers to become comfortable with common research species.

To promote consistency among teachers and provide a set of tenets with which to determine whether our educational goals had been met, it was important to identify a theoretical framework on which to build our training program. In light of recent literature for training in the field of laboratory animal science[12] and the study of adult learning and teaching,[6,8,9,13,28] it was decided that situated learning theory would best serve as a theoretical framework in designing a hands-on training program for responsible care and use of laboratory animals.

Situated learning theory supports the notion that students learn skills for everyday living by practicing them within realistic contexts.[28] This theory recognizes that formal education settings (like classrooms, whether virtual or concrete) tend to decontextualize and over-simplify information, potentially promoting understanding of the material that is "rigid, incomplete and naive."[8] Because the content is separated from its natural circumstances when presented in the classroom or online setting, students may be less likely to be exposed to the skills and knowledge that experts use in 'real life.' The end result can be students who "may pass exams but be unable to apply the same knowledge in everyday circumstances."[8] Situated learning theory recognizes that "learners think and behave differently in everyday versus controlled environments."[8] In the same way that learning a language while immersed in its culture and setting is more effective than is memorizing vocabulary words, students learn skills for everyday living best when immersed in the complex environments in which they naturally occur. Whether learning a language or a skill, the meaning and application of each is much more a product of the setting than of a decontextualized text.

Pedagogically, under the tenets of situated learning theory, students learn as apprentices within a community of practitioners as they use the tools and language of the field.[6,9,13,28] Situated learning emphasizes the social nature of learning whereby the goal is to increasingly involve the student in a community of practice, helping them move from the margin of the community to the center and ultimately engaging them as members of the community.[13] Furthermore, situated learning emphasizes the importance of creating authentic and supportive learning environments that allow for the exploration of complex challenges of everyday life.

Although situated learning theory itself has not previously been described as the basis for providing training in the field of laboratory animal science, promoting authentic learning experiences has been suggested as an important strategy in supporting adult learning in this field.[12] Furthermore, pairing experts with novices in 'cognitive apprenticeships' within an authentic setting has been described as a means to help enculturate students into a community of practice with in the animal research setting.[12] Similarly, a recent publication that described a novel electronic learning program for laboratory animal surgery recommended that students benefit from a hybrid model that includes both authentic experiences (hands-on training) and reference materials.[3] Although the use of authentic experiences for students who need to learn techniques with animals has been suggested, the pedagogic effect of hands-on training designed with situated learning as its theoretical framework has not been tested directly. In addition, the benefit of researchers who become members of a community of practice and its implications for relationships between researchers and animal care personnel as an outcome of authentic in situ training has largely been overlooked.

In response to a need to explore the best practices for training in the field of laboratory animal science, the purpose of this mixed-method study was to investigate the effect of a hands-on training program on student comfort with laboratory animals and collegial relationships between animal care personnel and researchers. Because of its emphasis on authentic experiences and the social nature of learning, we assumed that our hands-on training program for laboratory animal techniques, framed within situated learning theory, would improve comfort with laboratory animals and increase the likelihood of collegial relationships between researchers and animal care personnel.

Materials and Methods

This study used mixed method, involving a quasiexperimental (pre- and posttest) and a qualitative design. The quantitative design was used to ascertain changes in students' confidence in handling animals and the increased likelihood of their seeking out trainers as a result of attending a single hands-on training session. Demographic information was collected in this manner as well. Quantitative information was collected by using surveys before and after training. The qualitative design, an inductive

mode of inquiry comprising semistructured interviews, was used to collect data from a subset of participants at the end of each instructional series. The qualitative component of the study provided the opportunity to gain greater understanding of the in situ experience to determine specific aspects of the setting that influenced changes in self-assessed comfort and confidence as a result of the training.[18,23]

This study was approved by the Penn State College of Medicine Institutional Review Board. Consent was obtained from each participant, and all data collected were de-identified by assigning each participant a code that was available to the principal investigator only. All procedures performed during the training sessions were described in an animal care-and-use protocol approved by the Penn State College of Medicine IACUC.

The Responsible Care and Use of Laboratory Animals Training Program consists of 8 training sessions, each 2 to 3 h in length. Each participant electronically receives a set of notes prior to each session. The notes contain a variety of resources including images of techniques that will be performed, links to video recordings that demonstrate techniques, and vendor information for commonly used equipment. All training sessions begin with exercises that promote social interaction. Depending on the topic, group discussion follows to clarify concepts. Participants then divide into small groups, with a student:teacher ratio of no greater than 3:1, to practice techniques. When possible, multiple styles of commonly used research equipment (for example, a variety of perioperative warming devices) are used during the training to create authentic situations. Simulation devices like the Koken rat (Koken Company, Tokyo, Japan) and Squeekums rat (Rescue Critters!, Thales and Company, Van Nuys, CA) are used for the purposes of introducing basic skills. However, in keeping with the tenets of situated learning, the students practice with live animals. These animals are surplus, research-naive rodents that are available as the result of 'experimental overflow'[10] and are deeply anesthetized either with a mixture of ketamine (rat, 60 mg/kg; mouse, 100 mg/kg; Ketathesia, Butler Animal Health Supply, Dublin, OH), xylazine (rat, 10 mg/kg; mouse, 5 mg/kg; AnaSed, Akorn, Decatur, IL), and acepromazine (rat, 1 mg/kg; mouse, 2.5 mg/kg; Acepromazine Maleate Injection, Phoenix Pharmaceuticals, St Joseph, MO) or with isoflurane (induction, 5%; maintenance, 1 % to 2%; Isothesia, Butler Schein, Dublin, OH) for any procedure that would cause more than momentary discomfort. The instructors guide each student through increasingly complex aspects of each procedure until each student can perform the technique independently. Techniques checklists[12] are used during class to support metacognition and to document whether the student has successfully completed the procedure independently. Students complete a written anonymous evaluation after each class to provide feedback to instructors and to encourage reflection about the content.[12] Any animal anesthetized for the purposes of allowing students to practice potentially painful techniques is euthanized prior to recovery from anesthesia as described in the approved IACUC protocol.

Teachers for the program include clinical veterinarians, research technicians, and veterinary residents enrolled in the Penn State College of Medicine Comparative Medicine Residency Program. Training sessions for all teachers are held weekly in advance of each topic. During these sessions, teachers practice not only the hands-on techniques but also plan how they will engage students in conversation about their prior experiences[12] and research needs. Training on the tenets of situated learning is provided quarterly by invited speakers from the field of adult education and is reinforced during weekly practice sessions.

Study participants identified themselves as research technicians (28.3%), graduate students (15.2%), postdoctoral fellows (19.6%), principal investigators (8.7%), medical students (4.3%), and other (23.9%). There were more female (63%) participants than male (37%). Participant ages ranged from 18 to 25 y (26.1%), 25 to 30 y (23.9%), 30 to 35 y (23%), and over 35 y (26%). Years of experience in the field of biomedical research ranged from less than 5 y (50%) to greater than 20 y (6.5%), with 43.5% reporting between 5 and 15 y of experience. Most participants spoke English as their native language (80.4%), and most had owned a pet in the past (69.6%). Although animal care technicians employed by the Department of Comparative Medicine were participants in the training program, they were excluded from the study to minimize bias.

Surveys. Participants were invited individually by electronic mail to participate in the study. Survey questions were designed within a commercially available online survey program (SurveyMonkey, Palo Alto, CA, www.surveymonkey.com), a link to which was included in the communication to participants. Participation in the survey indicated consent, as described in the survey introduction, as per the approved Institutional Review Board protocol. The first survey ($n = 49$) was designed to collect demographic data and self-reported pretraining comfort levels with animals and animal care personnel. The second survey ($n = 35$) was designed to collect data on the same self-reported comfort levels after the first training session (3 wk after the first survey, to allow sufficient time for all participants to complete the first session). The discrepancy in the number of participants in the pretraining survey compared with the posttraining survey is explained by the transient nature of some of the participants (for example, summer students), resulting in some of the participants not completing the second survey.

Surveys included scaled (Likert-style) responses about comfort levels with animals. For example, responses to the question "What kind of experience would handling each of the following species of laboratory rodent be for you?" ranged from 1 (frightening) to 5 (enjoyable). The second survey included open-ended questions about the aspects of training that helped or hindered comfort levels with animals and personnel (Figure 1). Participants' responses to pre- and posttraining surveys were tracked by a personalized code that allowed de-identification of the participant yet enabled the comparison of responses for each participant.

Interviews. Qualitative data were collected by conducting semistructured interviews with a purposeful sample ($n = 10$) of participants. Semistructured interviews involve asking the same basic questions during each interview but pursuing unique participant responses with spontaneous follow-up questions and having flexibility regarding the order and wording of questions.[20] Sample interview questions are provided in Figure 2. Purposeful sampling means choosing participants according to the research question to produce rich, descriptive data.[19,20] Only subjects who had already completed the online surveys and had participated in the hands-on training were invited to participate in the interview. The goal of qualitative research is to reveal how subjects make meaning of a specific phenomenon.[19,20] In this case, we wanted to capture the specific aspects of the hands-on training program that were meaningful to the participants. Each interview was audio-recorded by using a digital voice-recording device (model ICDUX70, Sony Electronics) and transcribed by using commercially available transcription software (Express Scribe Transcription Software, NCH Software, Greenwood Village, CO). Open coding was performed for each transcription, during which all possible

Please describe aspects of the Rodent Handling Training session that helped with your comfort level for handling rodents.

Please describe aspects of the Rodent Handling Training session that hindered your comfort level for handling rodents.

Please describe aspects of the Rodent Handling Training session that promoted a sense of collaboration between trainers and participants.

Please describe aspects of the Rodent Handling Training session that did not promote a sense of collaboration between trainers and participants.

Figure 1. Open-ended questions posed to study participants within the posttraining survey.

Reflect back on working with laboratory rodents before the training sessions. What feelings were associated with that experience? How would you describe your comfort level? Describe what it was like to perform a technique with a laboratory rodent.

Now that you have completed the training sessions, please describe feelings associated with working with rodents and your current comfort level. Describe what it is currently like to perform a technique with a laboratory rodent.

Please talk about some of the experiences you remember most from the training sessions.

Please name 2 or 3 activities that you found most useful and 2 or 3 activities that you found least useful.

How do you think the training sessions impacted the degree of confidence you have in your knowledge of rodents?

Think about a laboratory animal related problem you have had in the past and describe how you would have handled it then. Explain who you contacted for help at the time and the end result.

Now that you have completed the training sessions, please explain how you would approach a laboratory-animal–related problem.

Please describe aspects of the hands-on training program that you think promoted collaborative relationships between participants and instructors, if any. Were there any aspects of the training program that hindered collaborative relationships?

Figure 2. Examples of questions posed to study participants during semistructured interviews.

meanings of the data were considered. Data collected through open coding of the transcriptions then were placed into categories that were mutually exclusive, conceptually congruent, and "responsive to the purpose of the research,"[20] a process called axial coding. Analysis of data and categories continued by using the constant comparative method until there was consensus on interpretation of the data.[20] Once saturation was achieved (no new categories of data emerged), the qualitative aspect of the study was considered to be complete.[19,20]

Statistical analysis. Means and standard deviations were calculated for pre- and posttest values for responses to Likert-style questions. A 2-tailed *t* test of differences between the means for each item was conducted by using SPSS software (version 21.0, SPSS Statistics for Windows, IBM, Armonk, NY), and the criterion for statistical significance was set as a *P* value less than 0.05.

Results

Quantitative data. Mean values for responses to Likert-style survey questions are reported in Table 1. Results of a 2-tailed *t* test used to compare pre- and posttest responses of participants who completed both surveys are shown in Table 2. Self-reported knowledge and capability improved significantly ($P < 0.05$ for each) after one hands-on training session. Self-described confidence levels with both rats and mice also significantly improved after one hands-on training session ($P < 0.05$ for each) as did participants' descriptions of what handling a rat or mouse would be like ($P <$ 0 0.05 for both rats and mice). Likelihood that participants would contact staff from the Department of Comparative Medicine for assistance improved for all 3 categories: techniques, physiology questions, and animal illness ($P < 0.05$ for each). The only question for which there was not a statistically significant improvement was the question that asked participants to rank their agreement with the statement about the staff of the Department of Comparative Medicine as the best source of information. Whereas the mean responses showed a trend toward positive improvement (pretraining, 3.77; posttraining, 4.14; $n = 35$), the *P* value (0.146) did not fall below our set cut-off for significance (0.05). Responses to the open-ended survey questions were included in the qualitative data and analyzed using open coding, axial coding and constant comparative method and are included below.

Qualitative data. Four themes emerged from the data analysis of the transcribed interviews: seeing then doing, working in small groups, learning within a comfortable environment, and building collegial relationships. Within the final theme, 2 separate categories arose that further defined aspects of the training that contributed to improving comfort with trainers: sharing physical space and spending time together. The following defines each theme and provides representative data.

This group of students identified seeing then doing as a key aspect of the training that promoted their comfort level with laboratory rodents. This category captures the value that students placed on modeling of the technique and especially being given the opportunity to practice. For example, a female research technician with 5 to 10 y of experience in her field described her experience in the following way:

> You got to watch what they were doing, then you got to do it as well. That was nice. It just wasn't a sit-down class and that was it. You actually got to get your hands in there and do the stuff.

Likewise, a female graduate student in her late teens to early twenties with less than 5 y of experience working with laboratory animals

Table 1. Comparison of responses (mean and SD) to Likert-style questions (from 1 [poor] to 5 [excellent]) before and after the rodent handling training session

	Pretraining (n = 49)[a]	SD	Pretraining (n = 35)	SD	Posttraining (n = 35)	SD
How would you rate your capability to restrain rodents in your research?	3.37	1.03	3.32	1.04	4.06	0.74
What kind of experience would handling a rat be for you?	3.02	1.18	3.09	1.18	3.88	1.05
What kind of experience would handling a mouse be for you?	3.43	1.13	3.42	1.14	3.91	0.72
Please rate your level of confidence with laboratory rats.	2.77	1.22	2.76	1.22	3.88	0.99
Please rate your level of confidence with laboratory mice.	3.33	1.37	3.30	1.29	4.12	1.05
What is the likelihood that you would consult with the staff of the Department of Comparative Medicine for help with laboratory animal techniques?	3.96	0.93	3.82	1.00	4.35	0.85
What is the likelihood that you wouldconsult with the staff of the Department of Comparative Medicine for questions about laboratory animal physiology?	3.89	0.98	3.76	1.03	4.18	0.77
What is the likelihood that you would consult with the staff of the Department of Comparative Medicine for questions about illness among your research animals?	4.34	0.89	4.27	0.98	4.72	0.57
To what extent do you agree with this statement: "The best source of information about laboratory animal care is the staff of the Department of Comparative Medicine?"	3.90	0.96	3.77	1.02	4.14	1.07
How would you rate your knowledge about laboratory rodents?	2.98	0.91	2.97	0.87	3.61	0.78

[a] There were 49 study participants who completed the pretraining survey. Of those participants, 14 were lost to follow-up and did not complete the posttraining survey.

explained what being able to practice skills meant to her, particularly in comparison to alternative methods of learning content:

> I think it was just the whole idea of it; the hands on idea of being able to touch the mouse and feel it and put a needle in it myself and that kind of thing. Because it's one thing to like look at it and read about it and hear about it, but actually going ahead and doing it is still a little nerve-wracking because you're like: "Am I exactly where I should be?"

An additional theme that emerged from analysis of the qualitative data was working in small groups. Participants in the study reported that more intimate social groups for learning improved their confidence and comfort while practicing techniques. As one young male participant with less than 5 y experience explained, "Working in groups with my peers helped me feel more comfortable handling the animals. If they could do it, then I had confidence I could as well." Likewise, a female postdoctoral fellow in her early 30s found that small groups made the learning environment less intimidating: "Small groups made it less intimidating if the student were to make a mistake or have a question." Participants reported not only learning from the trainers within the small groups, but also from one another. They reported that seeing others make mistakes ("seeing people not doing it right, [then] sort of testing your skills") and talking through the procedures with peers ("being able to collaborate with the other people and being able to talk it out") were key aspects of working in small groups.

Students reported that learning within a comfortable environment, or creating a less formal social environment for learning, made it easier for them to ask questions and practice techniques. For example, a young, female research technician commented that: "They [the trainers] made everyone feel comfortable, you know? They urged people to ask questions or even asked questions themselves and encouraged us to answer them. And a lot of us did, so it was a comfortable setting." Similarly, a postdoctoral fellow in her early 30s found that the "informality of the session made asking questions more comfortable." One participant, a young female graduate student with less than 5 y of experience in her field, described the effect of being comforted by her trainer on her learning experience:

> I think actually being able to hold the animals, do the techniques myself, etc., really made me feel better about my handling skills. Not to mention, having the veterinarians present and acting in a comforting level made taking those first steps to touch the animals or attempt a technique easier.

This student and her colleagues identified the casual atmosphere and comforting demeanor of the teachers as key

Table 2. Results of the 2-tailed *t* test used to compare differences between the means for each survey question

	t	*P*[a]
How would you rate your capability to restrain rodents in your research?	−4.186	**0.000**
What kind of experience would handling a rat be for you?	−4.713	**0.000**
What kind of experience would handling a mouse be for you?	−3.200	**0.003**
Please rate your level of confidence with laboratory rats.	−5.523	**0.000**
Please rate your level of confidence with laboratory mice.	−5.815	**0.000**
What is the likelihood that you would consult with the staff of the Department of Comparative Medicine for help with laboratory animal techniques?	−2.788	**0.009**
What is the likelihood that you would consult with the staff of the Department of Comparative Medicine for questions about laboratory animal physiology?	−2.435	**0.021**
What is the likelihood that you would consult with the staff of the Department of Comparative Medicine for questions about illness among your research animals?	−3.464	**0.002**
To what extent do you agree with this statement: "The best source of information about laboratory animal care is the staff of the Department of Comparative Medicine?"	−1.489	0.146
How would you rate your knowledge about laboratory rodents?	−4.875	**0.000**

[a]Pre- and posttraining results were compared only for respondents who completed both surveys (n = 35). Significant P values (that is, less than 0.05) are bolded.

components of being able to become more comfortable with the animals, and in turn, this comfortable learning environment provided the foundation for collaborative relationships to be built.

The final theme that emerged from the qualitative data was building collegial relationships. There were 2 aspects of this theme that students recognized as contributing factors: sharing physical space and spending time together. Students observed that one reason that they would not have contacted veterinarians or other members of the training staff for assistance in the past was that they were seldom in the same physical space. As one research technician with more than 20 y of experience in her field explained:

> I think we're so far removed from where any of our animals are housed down there we usually are taking our animals up to the lab at the far end of the building so we don't actually see them [veterinary staff] on a day-to-day basis or have an interaction with them.

Similarly, a research technician in her late 30s with 10 y of experience identified location as a barrier to social contact: "we're not always downstairs all the time and they're [veterinarians and animal care staff] always down here so you don't always see them…" Being together in the same space during the training sessions was viewed as a means of addressing these obstacles as was succinctly illustrated in this response: "I think just seeing and interacting with the trainers was enough." Another student identified the proximity of the veterinarians as a benefit of the training sessions: "we got to experience the lab and the vets were right there next to us." As a consequence of sharing the same physical space, students reported feeling more comfortable approaching the trainers and veterinarians outside of the context of training: "I feel more comfortable approaching the vets if I see them down here and have a question."

The second of 2 categories that support the building relationships theme is spending time together. Students identified this process as having a significant impact on the likelihood of contacting trainers and veterinarians for assistance. For example, one graduate student recognized that working closely with the veterinarian during class reduced the amount of anxiety that was associated with contacting the veterinarian for a question or problem: "I think just spending one-on-one time in general helped because I was always more afraid of the staff and now I realize that we all are human beings in this process together." Another graduate student reported that time spent together during class helped her to overcome feeling shy around the veterinarians: "I find myself to be a shy person when I don't know someone, so getting to introduce myself and interact with the staff over the sessions made me feel much more comfortable with going to them for help." The time spent interacting during the training sessions allowed preconceived notions about the role of the veterinarian to be revised, as illustrated in this response:

> …and realizing that they're [veterinarians and trainers] real people too, like we have ice breakers at the beginning and just going around the room and realizing that they're real people and they're here to help you not that they're here as veterinarians, you know? They do have this additional role of not only taking care of the animals but helping you do research that involves animals. I think just getting…to know them helped a lot with bridging that gap for me at least.

Therefore, it is clear that spending time with one another lowered prior physical and social barriers between researchers and veterinary staff at our institution, making way for the formation of collaborative relationships.

Discussion

Situated learning theory proposes that learning for everyday living should take place in realistic settings with opportunities to use the tools of the trade, solve authentic and complex problems, and to gradually become an integral member of a community of practice.[8,9,13,16,28] Using situated learning theory to inform practice, students engage in authentic activities (hands-on training) and in doing so learn from all aspects of the environment: peers, equipment, language, and culture. Similar to an apprenticeship model, teachers gradually remove pedagogic support until the student is able to independently perform the task, all the while socializing the student into the community in which the tasks will be performed.[16,28] Situated learning was chosen as a basis for our hands-on training program, established in August 2010, because we theorized that its features would not only provide opportunities for researchers to refine laboratory animal techniques in advance of projects but also build collegial relationships with veterinarians. Consistent with our hypothesis, results of our mixed-method study show that participants in the hands-on training program are more comfortable with laboratory rodents, more confident in their skills, and more likely to contact veterinarians after a single training session. In the qualitative arm of the study, participants specifically identified features of the training program that promoted their improved comfort with both animals and veterinarians. Those features were authentic experiences (seeing then doing), learning from peers (working in small groups), comfortable social environments, and opportunities for social contact with instructors, all of which are components of situated learning theory in practice.

Although situated learning theory applied to hands-on training in the field of laboratory animal science has not been explored before this study, the significant improvement in confidence posttraining that we observed is in agreement with other studies. For example, a study that explored confidence and ability of Australian veterinary students performing techniques with swine showed that self-assessed confidence improved significantly after a single hands-on training session compared with baseline self-assessments.[7] In contrast to our goal, which was to determine the effect of teaching animal research techniques from the theoretical perspective of situated cognition, the goal of the Australian study[7] was to explore which of a variety of resources best support students' confidence and ability. Similar to our findings, the cited study determined that of all the resources provided, including online resources and reflective sessions, those that involved hands-on interactions with the animals and direct contact with instructors were reported to be the most valued by the students.[7] However because the participants in that study were all veterinary students, it was thought that results might be biased toward any activities involving contact with animals.[7] Our results argue against this speculation, because none of our participants were veterinary students, and the pretraining survey results (confidence with rats, for example) indicate that many of our students were fearful of rodents prior to the training. The fact it has been reported that physician confidence improves as the result of practicing procedures with swine[23] is also in agreement with our findings and supports the notion that skillful provision of an authentic in situ experience can transfer even across species. The question of whether our students can successfully transfer skills from the training program to their labs may provide an explanation for one of our findings.

Our quantitative results showed consistent significant improvement from pretraining to posttraining on all survey questions except one. Furthermore, for each posttraining response that significantly improved, the standard deviation also decreased. This result indicates that there was less variance among the participants at the time of the survey after training and that those subjects who had lower responses during the pretraining survey had even greater improvement in score in the posttraining survey. These results indicate that our pedagogic intervention was successful overall; however the one question that trended toward positive improvement but did not satisfy our established criteria for significance should be explored.

As a means of evaluating whether instructors had established themselves as knowledgeable about laboratory animal techniques, we asked participants to rank their degree of agreement with the statement "The best source of information about laboratory animal care is the staff of the Department of Comparative Medicine." Although the trend was toward improvement (see Table 1), the paired *t* test did not identify the difference as statistically significant. Part of the reason for this finding may be that the question was designed initially as a ranking question, which provides data on an ordinal scale; the paired *t* test assumes interval data. Using a focus group to refine the survey design in advance of the study may have prevented this oversight. Another reason for the lack of significant improvement for this question may be that the hands-on sessions are focused on animal techniques rather than common bench-top techniques. Although every attempt is made to provide materials and supplies for practice that would be readily available in a laboratory environment and thus provide the most authentic experience, given the diversity of projects at our institution, we are not able to replicate the precise conditions of each laboratory. The end result may be that students perceive that trainers are valuable resources for basic animal techniques but not for specific research needs.

An additional limitation to our study was that the transient nature of the researchers who pursue hands-on training with research animals at our institution (summer undergraduate students, for example) created a discrepancy between the numbers of participants who completed the pretraining survey ($n = 49$) or both surveys ($n = 35$). As much as it would have been ideal for all participants to complete both surveys, comparisons of the mean responses for the pretraining surveys for the entire group compared with the subset of people who completed both surveys are consistent with one another (Table 1), making it unlikely that the posttraining results would have been much different. Along those same lines, it would have been valuable to collect additional survey information at the end of the series of training sessions to explore how relationships and confidence changed over the course of multiple sessions. We did not pursue this information because of a lack of consistency with the number of training sessions that each participant attended. Because some students only participated in 1 or 2 classes whereas others participated in all 8, it would not have been appropriate to compare all students. Instead, pre- and posttraining surveys were created for the prerequisite training class (rodent handling) so that the experiences of all study participants would be similar.

Finally, although the qualitative results of our study were most valuable for assessing and improving our program, they are not generalizable to other institutions by their very nature.[20,24] The goal of qualitative research is to produce rich, descriptive data that elucidates what meanings the participants ascribe to specific contexts and interactions they experience.[20,24] Although the data are not generalizable in the strictest sense, they can still provide useful insight for other institutions for methods of assessing performance outcomes for training pro-

grams[14] and gaining insight into the meanings and experiences of students enrolled in a hands-on training program.

Two important questions emerged during the study. Although situated learning recognizes the social component of learning and promotes the immersion of students into communities of practice, it does not address some common obstacles that we face as trainers. One common obstacle is that many of our students may not have proficient English language skills. Is it possible to integrate a student who has difficulty communicating into a community of practice? Future studies will explore the effect of situated learning on the pedagogic experience of nonnative English speakers. Although our study touched on the effect of social contact between teachers and students, we have not fully explored how relationships between teachers and students change as a result of providing an in situ learning experience. Future studies will be directed at addressing the power issues that are largely ignored by situated learning theory. Finally, because we believe that improved proficiency with skills and improved communication between veterinarians will contribute to animal welfare and improved quality of research data, future studies will be aimed at comparing noncompliance rates between personnel who complete online training alone and those who participate in hands-on training sessions.

This study is the first to explore the effect of teaching laboratory rodent techniques from the perspective and practice of situated learning. The findings showed that after a single hands-on training session, students felt more comfortable with the animals, more confident with their skills, and more at ease asking veterinarians for assistance. At a time when electronic learning is on the increase[23] and the use of animal procedure laboratories are on the decline,[11,21,23,25] our results provide justification for incorporating authentic experiences as an effective means of teaching laboratory animal skills. Opportunities to practice common procedures combined with the open communication that results from face-to-face interactions between veterinarians and researchers stand to improve the quality of data and promote collaboration.

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