

# Assessing the Effectiveness of a Cadaveric Teaching Model for Performing Arthrocentesis with Veterinary Students

Matthew D. Johnson ■ Linda S. Behar-Horenstein ■ Melissa A. MacIver ■ Yu Su

## ABSTRACT

The purpose of this study was to determine if a recently developed cadaveric canine model was an effective tool for teaching arthrocentesis to fourth-year veterinary students. Arthrocentesis is an important diagnostic tool and technical skill that can be difficult to teach in the clinical setting. Eighteen fourth-year veterinary students participated in a within-subjects experiment that evaluated their ability to successfully perform arthrocentesis in the canine model and in an unmodified control cadaver. Students completed an online survey about the experience. Ability to perform the procedure was assessed by monitoring the number of attempts and redirects required to enter the joint and by recording any volume recovered from the arthrocentesis. In both phases of the study, the participants were able to aspirate a measurable volume of fluid from the joints of the model. Participants recorded an increase in confidence with arthrocentesis after using the model in the first phase of the study and unanimously supported inclusion of the exercise in future teaching situations.

**Key words:** clinical skill education, cadaveric model, joint model, canine joints, arthrocentesis training, veterinary students

## INTRODUCTION

Arthrocentesis is a valuable analytical tool in the diagnosis of many intra-articular conditions. In a 2002 survey of Canadian Veterinary Medical Association members, 76% of respondents indicated that lack of confidence, competence, or both, with respect to skills expected of new graduates, was a moderately serious to extremely serious problem.<sup>1</sup> In a study examining a model to improve student confidence in diagnostic sample collection, students identified arthrocentesis, among other diagnostic skills, as a procedure that they lacked the confidence or competence to perform.<sup>2</sup> Of that sample of students, only 16%–20% had the opportunity to perform arthrocentesis at least once in the first 3 years of veterinary school. When students across all 4 years of veterinary training were surveyed, the number increased to 67%.<sup>2</sup> In the same study, recent graduates reported that, regardless of personal comfort with performing arthrocentesis, they had a colleague either perform the procedure for them (33%) or supervise them (66%).<sup>2</sup>

Teaching arthrocentesis in the clinical setting can be challenging in both human and veterinary medicine due to the invasive nature of the procedure. Becoming proficient in this task without placing patients at risk is difficult in the clinical setting.<sup>3</sup> The use of live animals for teaching invasive procedures poses an ethical concern for animal welfare and can have an emotional impact on students, instructors, and clients.<sup>2,4,5</sup> For these reasons, performing invasive procedures on live animals for

teaching purposes has largely fallen out of favor in the veterinary context.<sup>4</sup>

Models designed to assist medical students with arthrocentesis in human medicine have been evaluated in the literature. A study comparing the effectiveness of synthetic joint models and cadavers as teaching models was recently published and revealed that cadaveric models provided a more rapid and direct increase in comfort.<sup>3</sup> The authors did not describe the condition of the cadavers, namely whether they were fresh or previously frozen, or whether the joints had been prepared in any specific fashion. Synthetic models have been shown to increase students' comfort with the procedure and procedural confidence.<sup>6</sup> Advantages associated with synthetic models include their relatively low cost, portability, ease of access, and reusability. Synthetic models in veterinary curricula, although more prevalent in recent years, are still often the exception rather than the rule.<sup>4</sup> In addition, the introduction of new technologies can be delayed due to financial constraints associated with initial research and development or due to the cost of purchasing pre-existing technologies.

In veterinary medical curricula, cadavers used for teaching purposes are usually collected and stored frozen for prolonged periods until sufficient numbers are reached for use in laboratory teaching exercises. The availability of fresh cadavers is sporadic, making them difficult to use in a structured educational setting.

Cadavers that have been stored frozen and thawed for use typically have little to no joint fluid.<sup>7</sup> For this reason, we recently developed a canine cadaveric arthrocentesis model using hypertonic saline injected into the joints of thawed cadavers.<sup>7</sup> Our study demonstrated that measurable fluid samples could be obtained using this model up to 3 hours after injection.

The purpose of the present study was to assess and validate the cadaveric canine model as a teaching instrument among veterinary students. We hypothesized that the model would improve student ability to successfully perform arthrocentesis in a cadaver model. In addition, we hypothesized that the experience would improve student confidence for performing this procedure on a live patient in the future.

## MATERIAL AND METHODS

We performed a small cohort study in which we used a within-subjects experimental design. This is an experimental design in which all participants are exposed to both treatments.<sup>8</sup> Each participant performed arthrocentesis on a treatment cadaver or a control cadaver for the two phases of the experiment. Participants were blinded to the cadaver type on which they performed arthrocentesis for each phase of the study. Participation in the study was sought from fourth-year veterinary students after approval from the Institutional Review Board of the University of Florida. No academic incentives were offered, although free pizza was provided to participants upon completion of each session. Eighteen student volunteers were enrolled in the study. Eighteen medium-sized canine cadavers (estimated weight 20–30 kg), euthanized for reasons unrelated to this study, were used in the study; nine cadavers were used as models and nine as controls. The Institutional Animal Care and Use Committee approved the use of cadavers in compliance with the “Principles of Laboratory Animal Care” formulated by the National Society for Medical Research.

All participants were enrolled in and recruited from an Advanced Small Animal Surgery Laboratory course. Participants were randomly assigned to one of two cadaver groups and students were paired off within each group. The within-subjects design was executed in two phases on separate days to accommodate student schedules and cadaver availability. For phase 1, 10 participants were assigned to treatment cadavers and 8 participants were assigned to control cadavers. Participants were instructed, though not required, to watch three online videos that demonstrated the arthrocentesis procedure in the three joints used in the study—the carpus, elbow, and stifle. The videos were available at least 36 hours before the first session. The participants were allowed to watch the videos as many times as they desired before the first session. For phase 2, participants were assigned to the opposite cadaver group.

Cadavers were randomly assigned either to “treatment” or “control.” Treatment cadaver joints were injected with hypertonic saline in all tested joints by a single investigator (MJ). Joints used in the study were injected bilaterally. The volumes injected into each joint were as follows: stifle (8 ml), elbow (5 ml), and carpus (3 ml). The joints were

injected approximately 4 hours before the study. The choice of hypertonic saline and the volumes injected into each joint were based on a previous study.<sup>7</sup> Due to timing limitations imposed by the course schedule, it was not possible to inject the joint within the 3-hour time restraint of the previous study and all joints were aspirated 4 hours after injection. Thus, the injected volumes used in this study were increased compared to the injected volumes used in the previous study.<sup>7</sup> The increased volumes were determined empirically based on the overall decrease in aspirated fluid documented in the previous study.<sup>7</sup> Maximum joint capacity was not reached in the stifle and elbows with the increased injection volume; the carpus in some dogs, however, could not accommodate more than 2 ml, similar to the volume in the MacIver study.<sup>7</sup>

Participants were asked to complete an online survey following each session (see Appendix 1). Participants were given a hard copy of the questionnaire immediately before commencement of the study so that they could record any potentially relevant information that came up during the study. Participants were instructed to keep the questionnaire to assist them in filling out the online version.

For the purpose of this study, an *attempt* at arthrocentesis was defined as the placement of the needle through the skin surface until removal of the needle from the skin. A *redirect* was defined as an alteration in orientation or direction of the needle while still within the cadaver. Redirects were limited to five per attempt. Participants were permitted three attempts per joint. When the participants felt they had entered the joint space, they were instructed to aspirate the joint and record the volume of recovered fluid (if any). For volumes that were too small to accurately measure, as in fluid observed only within the hub of the needle, the participants were instructed to record the volume as “trace.”

## Statistical Analysis

Each participant served as his/her own control. To compare the differences between participants in treatment and control groups, a *t*-test was conducted for normally distributed pooled item responses. The Mann-Whitney *U* test was used for non-normally distributed pooled item responses. Significance was set at  $p < .05$ .

Data from the questionnaire that related to evaluation of the cadaveric model versus the unmodified cadaver were pooled among all participants and were compared using a *t*-test. Significance was set at  $p < .05$ .

## RESULTS

### Participant Performance: Phase 1 and 2

All participants completed the online questionnaire after each phase of the study. Based on these questionnaire results, there was no significant difference between the participants within the treatment and control groups with respect to prior performance of an arthrocentesis procedure, perceived helpfulness of the instructional video, ability to palpate anatomic landmarks described in the video, and ability to place the needle within the joint (carpus, elbow, or stifle) on the first attempt (Table 1). All

**Table 1:** Comparison of performance, palpation, ability to place needle, number of redirects, and successful arthrocentesis by phase

Questionnaire	Phase 1			Phase 2		
	Treatment	Control	<i>p</i>	Treatment	Control	<i>p</i>
Prior performance (Q1)	0.44	0.67	.436	0.00	0.22	.444
Palpation of landmarks (Q5)	2.0	2.33	.258	2.44	2.56	.713
Ability to place needle within joint, first attempt (Q8a–c)	4.11	4.88	.222	4.33	5.00	.581
Number of redirects (Q9)	7.89	14.89	.002*	10.66	13.56	.216
Ability to successfully perform arthrocentesis (Q6–9c)	14	22	.004*	17.44	21.22	.236

For prior performance, palpation of landmarks, ability to place needle within the joint on the first attempt, number of redirects, and ability to successfully perform arthrocentesis, a lower mean score indicates better performance.

\**p* < .05 indicates significant difference was found between the two groups.

**Table 2:** Comparison of video utility and confidence by phase

Questionnaire	Phase 1			Phase 2		
	Treatment	Control	<i>p</i>	Treatment	Control	<i>p</i>
Helpfulness of video (Q4)	9.11	8.00	.258	8.89	9.11	.612
Confidence in performing in live patient (Q12)	9.56	7.66	.032*	8.89	8.78	.509

For helpfulness of video and confidence in performance in live patient, a higher mean score indicates better performance.

\**p* < .05 indicates significant difference was found between the two groups.

**Table 3:** Comparison of cadaveric model (treatment) vs. unmodified cadaver (control)

Questionnaire	Treatment	Control	<i>p</i>
Palpation of landmarks (Q5)	2.22	2.44	.443
Ability to place needle within joint, first attempt (Q8a–c)	4.22	4.94	.171
Number of redirects (Q9)	9.28	14.22	.012*
Volume recovered (Q11a–c)	3.08	0.48	<.001*

For the first three rows a decreased value indicates a better performance.

\**p* < .05 indicates significant difference was found between two groups.

participants unanimously indicated that this exercise/procedure should be included as part of the curriculum for next year's laboratory course.

### Participant Performance: Phase 1

Based on the data from phase 1, there were some differences between participants in the treatment and control groups. There was a significant difference between the treatment and control groups with regards to participants' need to redirect the needle in any of the joints (stifle, elbow, carpus). The mean score for the treatment group was 7.89 compared to 14.89 for the control group (*p* = .002), indicating more redirects were required in the control cadavers. Furthermore, there was a significant difference between the participants' confidence in performing the procedure in a live patient when the treatment and control groups were compared. The mean score for the treatment group was 9.63 compared to 7.8 for the control group (*p* = .032). Pooling the results of specific questions designed to measure the participants' ability to successfully perform an arthrocentesis proce-

dure (Q5–9c) illustrated a significant difference in the measure of ability between the participants in the treatment group and those in the control group. The mean score for the treatment group was 11.88 compared to 19.7 for the control group (*p* = .004), suggesting that perhaps the control group had less ability, or conversely that the model aided the participants in recognizing when they were in the joint (Tables 1 and 2).

### Cadaveric Model vs. Unmodified Cadaver

Certain questions from the questionnaire were intended to evaluate the use of the cadaveric model versus the unmodified cadaver. Comparing the results of all participants that used the treatment cadavers to those that used the control cadavers (regardless of phase) showed a significant difference in the number of redirects needed in the treatment cadavers as compared to the control cadavers (9.28 and 14.22, respectively, *p* = .012). In addition, there was a significant difference in volume recovered from the treatment cadavers and control cadavers (3.08 ml and 0.48 ml, respectively, *p* < .001) (Table 3).

## DISCUSSION

In this study, we sought to assess the student experience with a recently developed cadaveric model.<sup>7</sup> The study used a within-subjects experimental design.<sup>8</sup> This approach is advantageous because it does not require a large pool of participants and helps reduce errors associated with individual differences.<sup>8</sup>

The results of the questionnaire indicated that there was no difference in experience level between participants in the cadaveric groups of both phases. Given the nature of the within-subjects study design, this is not surprising. Examination of each phase did not reveal differences among the students with regards to experience and grouping.

Interestingly, there was no significant difference in response between participants in either cadaveric group regarding the helpfulness of the instructional video. All students watched the video before the first session. The initial cadaver group to which the participants were assigned did not affect the perceived helpfulness of the video. There was no significant difference in the ability of the two groups to palpate the joint landmarks for arthrocentesis. This indicates that the landmarks demonstrated and described in the video with an unmodified cadaver were present and similar in the treatment cadavers, and that joints were not overly distended to the point that palpating landmarks was difficult.

Regarding participants' ability to enter the joint on the first attempt, there was no significant difference in the responses of the two cadaveric groups. However, there was a difference with respect to the number of redirects that were needed to successfully place the needle among the participants in phase 1. This difference was also noted when all redirects for the treatment cadavers were compared to the redirects needed for the control cadavers. To the less experienced practitioner, the "pop" of the needle that can be felt when entering the joint may be less distinct, making aspiration of fluid the first indication that the joint has been successfully entered. This may account for the lower number of redirects among the treatment group participants in that they could aspirate fluid from the joint to assure themselves they had successfully entered the joint. Participants working with the control cadavers may have redirected more times because there was no measurable fluid or only a small amount of aspirated fluid with which to confirm correct placement within the joint. The higher mean score for the treatment group compared to the control group suggests that perhaps the control group had less ability, despite their apparent equivalent level of experience performing arthrocentesis. Alternatively, this finding might reflect that the treatment group had fluid in the joint with which to confirm proper needle placement, whereas the control group had less visual confirmation of success and so kept trying.

For phase 2, there was no significant difference in redirects between participants using treatment cadavers and control cadavers. This is likely due to the carryover effect from phase 1. Unmodified cadavers have been used successfully previously in the instruction of students for arthrocentesis.<sup>2,3</sup> This study did not attempt to refute the usefulness of unmodified cadavers. We did

seek to determine if there were advantages to using the modified cadavers. The lack of difference among participants in phase 2 likely indicates that all participants benefited from their experience in phase 1 regardless of the cadaver group to which they were assigned.

The treatment cadavers recorded an increased volume of fluid recovered from joints compared to the control cadavers in both phase 1 ( $p = .009$ ) and phase 2 ( $p = .001$ ). This is consistent with the previous study published by MacIver. We had to modify the protocol from that study slightly to accommodate a longer interval of 4 hours rather than the maximum of 3 hours between injection of the joint and aspiration. We increased the volume injected in the elbow and stifle in hopes of countering the decreased diagnostic yield over time noted in that study. We were unable to consistently increase the injected volume of fluid in the carpus due to joint volume limitations. Our results show that the time from injection to collection can be extended to 4 hours in cadavers weighing 20–30 kg by increasing the volumes injected to 8 ml for the stifle and 5 ml for the elbow. Maximum joint distention did not appear to be reached for these joints even with this increase in volume.

The recovery of fluid from the joints of treatment cadavers may appear intuitive since these joints were injected with fluid for this purpose. The intent of this model is to create a clinical simulation to improve the experience of the exercise. The fact that participants were able to recover fluid from these models indicates the model was better able to give the participants a "realistic" experience. Since the participants did not have previous experience with arthrocentesis in live patients, we were not able to have participants comment on the cadaveric model in this manner.

Participants reported feeling more confident at being able to perform the procedure in a live patient after performing arthrocentesis for this study in phase 1. The lack of a measurable increase in confidence after the second phase is likely a reflection of the participants' familiarity with the procedure rather than an indicator of decreased confidence.

The results of this study appear to correlate with the results of the previous study establishing the validity of the model for teaching purposes.<sup>7</sup> Participants felt they were able to successfully perform an arthrocentesis in each joint regardless of whether or not they were performed in the control or treatment cadavers. This would at minimum indicate that the treatment cadavers perform at least as well as the unmodified cadavers. Furthermore, the findings of this study indicate potential advantages of injected cadavers.

There was a unanimous response from the participants that arthrocentesis on cadavers should be included in future laboratory exercises. Since the participants were blinded to the modifications performed on the cadavers, the unanimous response cannot be viewed as a specific endorsement of the modified cadaveric model but rather as an endorsement of the exercise of performing arthrocentesis on cadavers. This supports previous findings noting positive student responses to cadaveric training for arthrocentesis.<sup>2,3</sup> Based on this response, a trial with

a greater number of participants or further long-term evaluation of the effectiveness of this cadaveric model is warranted.

A limitation of the study was that we were unable to confirm whether or not the participants were definitively successful in their attempts at arthrocentesis in the control cadavers. The participants self-reported their own performance so it is possible that they did not report or failed to recognize their inability to access the joint space in control cadavers. To prevent them from feeling self-conscious, the questionnaire was filled out online and their individual information was censored before being released to the investigators. This process was explained to the participants before their participation. The treatment cadavers had, in effect, a "positive control" via collection of fluid, and so it was readily apparent whether or not a successful arthrocentesis was performed. Since the participants were blinded to the protocol of the study, they were unaware that any of the joints were injected and therefore would not have known whether fluid would be recovered or what volume would be appropriate to report.

Given that the significant differences between treatment and control were primarily observed in phase 1, it may be that the treatment group respondents in phase 1 discerned that they were part of an experimental process by the time they were assigned controls in phase 2. Also, due to the fact that insufficient cadavers were available to complete both phases in a single session, it is possible the participants discussed their experience between sessions; this may also have affected their performance in phase 2. The respondents were all classmates and discussion of the study was not specifically forbidden in the protocol. Lastly, all participants, regardless of which cadaver type they were initially assigned, may have been able to improve their skills in the first phase such that detectable differences between groups were harder to discern in the second phase due to the small number of participants.

A potential limitation of this research design is that a participant's experience in one condition can affect performance in the other conditions due to carryover effects. Another limitation of the study is the relatively small sample size. Initially it was hoped that all students ( $N = 82$ ) within the laboratory course would be willing to participate; however, participation in the study was completely voluntary. This study was designed as a pilot study to assess the potential usefulness of the model for teaching arthrocentesis to students. Subjectively, the students had positive experiences with the study. The injected joints gave the students immediate confirmation of successful entry into the distended joint capsule. Interestingly, though it was not part of the questionnaire design, during observation of the participants by the primary investigator (MJ), it appeared that the participants that were assigned the treatment cadavers for phase 1 were more frustrated with the control cadavers in the second session as they were unable to aspirate fluid volumes similar to their first experience. There was no significant difference in attempts or redirects between the participants within the phase 2 data. The consistent "positive fluid" arthrocentesis results in the treatment

cadaver may have given students the false impression that all joint taps should result in collection of fluid. However, as an introduction to the procedure, we feel the positive feedback from the model would help support good technique and confidence in the student clinician.

Similarly we did not inject a dye such as India ink or methylene blue into the joints to confirm after the study that the joints had indeed been successfully injected. Any color added to the fluid injection would have "unblinded" the participants to the study. The authors felt it was important to allow assessment of the model without the participants having knowledge as to whether or not they were performing arthrocentesis on the model of interest as that could have affected their response to some of the questions. The joint injections were all performed by one investigator (MJ) with extensive previous experience with arthrocentesis; this author also participated in the MacIver study.

In conclusion, we found that the model tested did increase student confidence in performing arthrocentesis. Although this was only noted in phase 1 of the study, the confidence in performance among these participants remained high in phase 2 when using control cadavers; the confidence among the participants using the treatment cadavers in phase 2 was also high. The injected joints provided immediate positive feedback and confirmation to the participants that they had successfully entered the joint. The participants reported an overall positive experience and universally recommended inclusion of cadaveric arthrocentesis in future teaching exercises.

## REFERENCES

- 1 Lavictoire S. Education, licensing, and the expanding scope of veterinary practice: members express their views. *Can Vet J.* 2003;44:282-4.
- 2 Williams LE, Nettifee-Osborne JA, Johnson JL. A model for improving student confidence and experience in diagnostic sample collection and interpretation. *J Vet Med Educ.* 2006;33(1):132-9. <http://dx.doi.org/10.3138/jvme.33.1.132>. Medline:16767653
- 3 Berman JR, Ben-Artzi A, Fisher MC, et al. A comparison of arthrocentesis teaching tools: cadavers, synthetic joint models, and the relative utility of different educational modalities in improving trainees' comfort with procedures. *J Clin Rheumatol.* 2012;18(4):175-9. Medline:22647857
- 4 Scalse RJ, Issenberg SB. Effective use of simulations for the teaching and acquisition of veterinary professional and clinical skills. *J Vet Med Educ.* 2005;32(4):461-7. <http://dx.doi.org/10.3138/jvme.32.4.461>. Medline:16421829
- 5 Patronek GJ, Rauch A. Systematic review of comparative studies examining alternatives to the harmful use of animals in biomedical education. *J Am Vet Med Assoc.* 2007;230(1):37-43. <http://dx.doi.org/10.2460/javma.230.1.37>. Medline:17199490
- 6 Jolly M, Hill A, Mataria M, et al. Influence of an interactive joint model injection workshop on physicians' musculoskeletal procedural skills. *J Rheumatol.* 2007;34(7):1576-9. Medline:17516616

7 MacIver MA, Johnson M. Development of a cadaveric model for arthrocentesis. *J Vet Med Educ*. 2015;42(2):140-5. <http://dx.doi.org/10.3138/jvme.1014-106R>. Medline:25862401

8 Cherry K. What is a within-subjects design? Overview, advantages and disadvantages of within-subjects design [Internet]. [cited 2014 Dec 23]. Available from: <http://psychology.about.com/od/windex/a/within-subjects-design.htm>

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## APPENDIX I

### Study Questionnaire

1. Have you ever performed an arthrocentesis procedure before this exercise?  
 Yes  No   
 a. If yes how many times?  
 <5  <10  >10
2. Did you watch the instructional video?  
 Yes  No
3. How long has it been since you watched the video?  
 <12hrs  12-24 hrs   
 more than 24 hrs and up to 48 hrs   
 more than 48 hrs and up to 72 hrs   
 more than 72 hrs
4. How helpful do you feel the instructional video was for performing the procedure?  
 0  1  2  3  4  5  6  7  8  9  10   
 0 = not helpful at all  
 10 = sufficiently helpful to prepare me for performing in the live patient without further practice
5. Were you able to palpate the landmarks as described in the video?  
 Yes  No   
 a. If no, circle in which joints you were unable to palpate landmarks  
 Stifle  Elbow  Carpus
6. Were you able to successfully perform the procedure in all joints?  
 Yes  No
7. If no, which joints were you unsuccessful in?  
 Stifle  Elbow  Carpus

8. Were you able to place the needle in the joint on the first try?

Stifle: Yes  No

Elbow: Yes  No

Carpus: Yes  No

a. For the **stifle**: if no, how many tries did you require?

2  3  unable to place needle

b. For the **elbow**: if no, how many tries did you require?

2  3  unable to place needle

c. For the **carpus**: if no, how many tries did you require?

2  3  unable to place needle

9. During the procedure did you have to redirect the needle?

Stifle: Yes  No

Elbow: Yes  No

Carpus: Yes  no

a. For the **stifle**: if yes, how many times did you redirect?

attempt #1: 1  2  3  4  5

attempt #2: 1  2  3  4  5

attempt #3: 1  2  3  4  5

b. For the **elbow**: if yes, how many times did you redirect?

attempt #1: 1  2  3  4  5

attempt #2: 1  2  3  4  5

attempt #3: 1  2  3  4  5

c. For the **carpus**: if yes, how many times did you redirect?

attempt #1: 1  2  3  4  5

attempt #2: 1  2  3  4  5

attempt #3: 1  2  3  4  5

10. For joint taps that were not successfully performed: why do you feel you did not enter the joint?

a. Unable to find joint space with needle

b. Needle may have entered joint but appeared to be at an odd angle

c. Appeared to enter joint—but did not recover fluid

d. Other reason. Explain:

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11. For joints you were successful in tapping, what was the volume recovered for each joint?

a. Carpus Trace: 0.1  0.2  0.3  >0.3  Enter volume \_\_\_\_\_

b. Elbow Trace: 0.1  0.2  0.3  >0.3  Enter volume \_\_\_\_\_

c. Stifle Trace: 0.1  0.2  0.3  >0.3  Enter volume \_\_\_\_\_

12. Having performed this exercise, how confident do you feel you could perform this procedure in a live patient?

0  1  2  3  4  5  6  7  8  9  10

0 = no confidence

10 = complete confidence

13. Should this exercise/procedure be included as part of the curriculum for next year's laboratory course?

Yes  No