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Developing and Implementing an Assessment Method to Evaluate a Virtual Canine Anatomy Program

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ABSTRACT

A computer-based anatomy program, *Virtual Canine Anatomy: The Head*, was incorporated into a first-year veterinary dissection laboratory two years ago to address challenges inherent in the traditional pedagogical approach. The program uses specimen photographs, QuickTime Virtual Reality, and interactive features to help students study the dissection, osteology, and radiology of the canine head. Photographs of each phase of dissection are displayed in the program, along with dissection instructions. Students can click on anatomical structures in each photograph to highlight the selected structure and display a complete description of it. Related structures and views are accessible through hyperlinks. This study was designed to measure student and faculty attitudes toward the instructional software, to gauge its effect on student achievement, and to propose evaluation methodology and instrumentation for similar projects. Observations, interviews, focus groups, surveys, and test results were used for this assessment. Results suggest positive student and faculty attitudes toward the program. Students felt the program met their needs, increased their confidence and efficiency, and was easy to use. Both students and instructors felt the program was beneficial during dissection. There was no significant change in student achievement on course tests. Future research will measure the program's effect on student–instructor interactions.

INTRODUCTION

Head and cranial nerve anatomy has historically been a very difficult topic to teach and learn in dissection laboratories.[1–6] In a limited amount of time, students must perform a complex dissection using illustrations in a technical, comprehensive book as their guide. Inefficient use of laboratory time forces students to study missed material outside of class, when instructors and cadavers may not be available.

In Colorado State University's gross anatomy course for professional veterinary medical students, two hours are allotted four times a week over 15 weeks for cadaver study. During this time, four instructors assist approximately 130 students and answer questions. Often, the majority of the instructors' time is spent identifying structures—time that could be spent discussing higher-level concepts such as clinical applications.

While waiting for an instructor's help, the students turn to textbooks for dissection assistance. These books are often comprehensive guides, which occupy the students during laboratory by forcing them to sort through an abundance of technical information to find material related to their course objectives (topics that students are expected to learn by the end of the course). Relevant information is presented in black-and-white two-dimensional illustrations that students must apply to their three-dimensional tasks. In addition, structures such as bones, muscles, and nerves are often separated into different illustrations, and the relative placement of one structure to another may be difficult for students to grasp.

Virtual Canine Anatomy: The Head was developed to address these problems. This CD-ROM program was designed to optimize the time students spend with instructors and cadavers. The program ideally prepares students before the laboratory, assists them during the laboratory, and allows them to study outside of the laboratory.

Students can use the program for dissection assistance. Sequential dissection instructions and images show students exactly what to expect during the laboratory session. The program features photographs of a dissected canine head that students can manipulate. Students can highlight structures by clicking on areas within them; information such as location and function is displayed when a structure is selected. These features act as an advanced organizer (introductory instruction that connects what the student already knows with what will be taught, which may facilitate learning).[7,8] While in the laboratory, students can compare their specimens with the specimens in the program. The dissection guidance also allows students to re-create the dissection experience for study when cadavers are not available. The software allows students to study anywhere, anytime, and at their own pace.[a]

The features in *Virtual Canine Anatomy: The Head* are aligned with current trends in instructional theories.[7–9] These features are expected to increase knowledge retention and knowledge transfer (application of the knowledge to new contexts) because the design of the program facilitates discovery of relevant material, mental organization of the subject, and integration of the material.[3, 7–10]

Students can easily find relevant information because descriptions of each structure are concise: Insertion, origin, innervation, and action of each structure are briefly stated.[7,8] In addition, relevant information is emphasized with cues such as italics, boldface text, highlights, and arrows.[7,8]

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The features in the program may facilitate mental organization of the material.[7,9,10] For example, the program is organized via a navigational map on which the information is grouped into major categories (such as osteology and radiology) and minor categories (such as deep and superficial dissection). The program accommodates students' needs by allowing them to jump directly to topics of interest. Students are not forced to use the program in a predetermined linear format. Maps outlining topics and subtopics may promote meaningful connections between new and existing knowledge.[9,10]

The format of the program may also help students integrate multiple representations of the material presented and make connections with their prior knowledge.[7,9] Related structures and views are linked together, fostering integration.[7] For example, alternate views of structures are available in QuickTime Virtual Reality (QTVR). Students can virtually rotate a two-dimensional representation of a dissected specimen using QTVR, giving them the illusion of working with a three-dimensional object.[11] The program also shows specimen photographs and descriptions concurrently, allowing students to integrate the verbal and pictorial representations of this information.[7] These organizational features can help students create a clear mental representation of the information, promoting knowledge retention and transfer.[7]

Our study was designed to determine whether the program met these goals. Survey and exam data from two cohorts of students were analyzed to measure student attitudes toward the program, to determine the program's effects on student outcomes, and to uncover possible areas for improvement. Interviews were conducted with faculty members to determine the instructors' attitudes towards the program.

We conducted our study not only to improve *Virtual Canine Anatomy: The Head* but also to develop evaluation methodology and instruments that can be used to study the effectiveness of similar programs. Although the number of computer-based anatomical guides is increasing,[2–,4,6,11–13] the outcomes and effectiveness of these programs are not always assessed. Assessment of these programs is important not only to improve and evaluate the instructional usefulness of these tools, but also to provide an overview to help anatomists choose appropriate programs for their needs and to guide in the development of efficient and effective teaching tools.[12–14]

METHODS

To examine the effectiveness of the program, data from two groups of students were analyzed: professional veterinary medical (PVM) students ($N = 112$) and masters of anatomy (MS) students ($N = 38$). We also interviewed the instructors of the PVM students ($N = 6$). Surveys, observations, focus groups, and course exam scores were used to examine the program's effects on the students and faculty.

PVM Survey

Each PVM student used the program during a two-week period while studying the anatomy of the head. Computers were provided at every dissection table, and four students worked at each table. Each student was also given a copy of the program for personal study.

The PVM survey consisted of 38 questions that measured students' attitudes toward the program on a 5-point Likert scale (5 = strong agreement with a statement, 1 = strong disagreement). Each survey question was worded positively, so that the student scores directly correlate with their level of acceptance of the innovation.

Each question represented one of seven categories that measured the following criteria:

1. *General Attitude:* Did the students have positive attitudes towards the program?
2. *Needs Met:* Did the program meet the students' academic and informational needs? Did the program help the students attain the course objectives?
3. *Dissection Assistance:* Did the program help the students during dissection?
4. *Confidence:* Did the program increase the students' confidence during laboratory?
5. *Content:* Was the content appropriate for the students' academic level? Was it accurate?
6. *Efficiency:* Did the program help the students make more efficient use of laboratory time?
7. *Usability:* Was the program easy to use?

Three to nine questions were empirically placed into each category. The validity of this placement was then verified by factor analysis.

PVM Observations

We observed the PVM dissection laboratories to examine how students and instructors used the program. We also kept note of any problems that occurred during laboratory sessions to find potential areas for improvement.

The program was used in the laboratory for two weeks while the students studied the canine head. At least one observer was present for the entirety of each two-hour laboratory, moving around the classroom and recording notes on a clipboard. To avoid disturbing the students' normal laboratory activities, the observers kept interaction to a minimum.

PVM Focus Group

Approximately 10 PVM students participated in a focus group after the head section of the course was completed. These were students elected by their class as group leaders. A focus group was conducted to speak with these PVM students directly about their experiences with the program in and out of the laboratory. Our aim was to determine the students' level of satisfaction with the program and to gather their suggestions for improvement.

Two observers were present during the focus group. One observer asked questions such as the following while the other manually recorded answers.

- What was your general experience with the program?
- How did you use the program?
- How would you compare the program to the book?

- Was it easy to navigate the program?
- Was the content appropriate?
- How could the program be improved?

MS Student Survey

The MS students also used the program while studying the anatomy of the head. The same equipment was provided for the MS students: A computer with the program was available at each dissection table, and four students worked at each table. However, unlike the PVM students, the MS students were divided into two groups. The experimental group ($N = 21$) used only the program during dissection, while the control group ($N = 17$) used only a textbook.

The experimental group was given the same survey the PVM students received, with the exception of 10 questions that were reworded for clarity.

MS Student Focus Group

A focus group was held with approximately 10 volunteer students from both the control group (students who used only a textbook) and the experimental group (students who used only the program). The focus group was held to learn about the experiences of both control and experimental groups, to determine the experimental group's attitudes towards the program, and to discuss areas for improvement.

Two observers were present during the focus group. One observer manually recorded answers while the other asked questions such as the following:

- How did the program group's experience compare to the book group's experience?
- How did you use the program?
- How could the program be improved?
- Was the content appropriate?

MS Student Tests

MS student scores on two course exams were analyzed. Our objective was to measure whether the program affected students' performance on questions pertaining to head anatomy. Two course exams covered the head section. Exam 1 had nine head questions and 42 non-head questions. Exam 2 had three head questions and 48 non-head questions.

Faculty Interviews

The PVM instructors were interviewed after students used the program in the laboratory. Interviews were conducted to assess the instructors' attitudes about the experience in laboratory and to discuss any perceived differences between traditional laboratories and laboratories using the program. Following are examples of questions from the interviews:

- What were your general feelings about the program?
- Was there a change in student efficiency?
- Was there a change in student questions (topic or frequency)?
- Were you prepared to use the program?
- What improvements could be made in the program?
- Would you like programs for the other topics of the course?

RESULTS

PVM Survey

Of 112 PVM students, 66 (58.9%) returned the survey. The category means for individual students were calculated. Class means for each category were calculated from these individual student scores (see Table 1).

The means for each category were above 4, indicating the students' agreement that the program met each of the seven criteria described under ''Methods: PVM Survey'': (1) General attitude, (2) Needs met, (3) Dissection assistance, (4) Confidence, (5) Content, (6) Efficiency, and (7) Usability.

MS Student Survey

Of the 21 MS students who used the program in the laboratory, nine (42.9%) returned the survey. Category means for each student were calculated. Class category means were calculated from these individual student scores (see Table 1).

The category means were above 3.6, showing that the MS students also agreed that the program met each of the criteria, but not as strongly as the PVM students.

Comparison of PVM and MS Students Surveys

The category means of the PVM and MS students' surveys were compared using a two-tailed independent samples *t*-test assuming equal variances[b] (see Table 1). Probability values were tested with $\alpha = 0.01$ because a more rigorous test was desired to account for the large difference in sample sizes. Category 2 (Needs met), Category 5 (Appropriate content), and Category 6 (Efficiency) showed significant differences. The PVM student responses were more positive in every category.

MS Student Tests

Exam scores for each student ($N = 38$) were analyzed. Means were calculated on questions related to the head and non-head questions for the control group and the experimental group (see Table 2). A one-tailed[c] independent-samples *t*-test assuming equal variances was performed to determine whether the use of the program led to better exam performance. No significant results were found (see Table 2).

DISCUSSION

This study analyzed the effect of a computer-based anatomical guide on student performance and measured student and instructor attitudes toward the program. Evaluations of computer-based anatomical guides help set standards for this emerging technology, help instructors to determine whether such programs enhance or detract from the learning experience, and provide instructors with a guide for choosing programs to meet their needs.[12–14]

This study analyzed students' experiences with an anatomical guide on CD-ROM to determine whether the program addressed the problems of traditional anatomy pedagogy.[1–6] The purpose of the program was not to supplant textbooks or instructors, or to replace the dissection activity, but to enhance the experience. Although the program provides features that emulate the actual dissection activity, such as QTVR rotations and photographs that illustrate each phase of dissection, the program does not provide the tactile experiences that are only available through dissection.

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Table.1: Comparison of PVM and MS students' survey category scores*

Survey Category	PVM ($N=66$)		MS ($N=9$)			
	M	SD	M	SD	t (73)	p
1. General attitude	4.33	0.59	4.22	0.55	0.51	0.61
2. Needs met	4.41	0.42	3.76	0.46	4.33	0.00
3. Dissection assistance	4.11	0.52	3.78	0.39	1.88	0.07
4. Confidence	4.19	0.54	3.86	0.37	2.21	0.03
5. Content	4.29	0.41	3.86	0.50	2.91	0.01
6. Efficiency	4.40	0.62	3.64	0.60	3.50	0.00
7. Usability	4.54	0.42	4.22	0.36	2.15	0.04

* Questions were rated 1–5 (5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly Disagree). Values of p were calculated using a two-tailed independent sample t-test assuming equal variances. Significant differences were determined with $\alpha = 0.01$. Examples of questions in each category are shown below:

Category	Example Question
1. General attitude	Overall, I enjoyed dissecting with the CD.
2. Needs met	The CD contained all of the functionalities that I desired.
3. Dissection assistance	The CD helped me know where to start cutting.
4. Confidence	The CD helped me feel less dependent on the professor.
5. Content	The content was consistent with other course references and material.
6. Efficiency	The CD helped me learn the objectives quickly.
7. Usability	It is easy to find information on the CD.

Table 2: Comparison of exam scores on head questions and non-head questions between experimental and control groups*

	Experimental ($N=21$)		Control ($N=17$)			
	M	SD	M	SD	t(36)	P
Exam 1						
Head questions ($N=9$)	0.85	0.15	0.86	0.15	0.09	0.46
Non-head questions (N = 42)	0.87	0.07	0.87	0.10	0.11	0.46
Exam 2						
Head questions ($N=3$)	0.83	0.20	0.78	0.16	−0.68	0.25
Non-head questions ($N=48$)	0.90	0.05	0.91	0.05	0.16	0.44

* Each question was worth a maximum of one point. Head questions were covered on the CD, while body questions were not. The experimental group used only the CD during lab, and the control group used only the book.

Tactile experiences increase psychomotor skills and facilitate student understanding of three-dimensional anatomy.[5,12,15] However, observations, focus groups, interviews, and surveys show that students and faculty felt the program was beneficial because it simplified the study of the canine head.

Interviews

Instructors agreed that the program enhanced the dissection experience. Students were more self-directed and less anxious during laboratory sessions, according to the instructors and according to our observations. The faculty praised the program as a strong visual aid and self-paced study guide for students. Some instructors indicated that the program gave them more opportunities to discuss higher-level issues with the students, such as structure functions and relationships. The instructors gave various suggestions for improvement, such as increasing coordination between the program and course objectives, including illustrations on the program, and decreasing information on each page. Overall, the instructors displayed very positive attitudes toward the program.

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Focus Groups

Both PVM and MS students expressed positive feelings toward the program. Dissection was easier for the students because the program helped them know what to expect, alleviating worries of cutting something important. Students appreciated the color photographs and acknowledged that the program was good for visual learners. The MS students reported that the images seemed three-dimensional and helped them visualize depth.

When comparing the textbook to the program, MS students indicated that the program was better organized than the textbook. MS students who had access only to the book sought help from those who used the program. If the PVM students had to choose one resource to use during laboratory, they unanimously chose the program, but they would prefer to have access to both. Both groups agreed that the program could not supplant the instructors.

Students used the program in various ways. Many PVM and MS students used the program outside the laboratory for study, and one student used the program exclusively when studying the head. Several students expected to use it outside the laboratory to illustrate concepts to clients and students in their classes. Some students reported that the program was user friendly, while others did not initially feel comfortable using it. Both groups wanted more tutorials on how to use the program.

Several improvements for the program were suggested. The PVM students wanted quiz features to test their understanding of the material. Both PVM and MS students were concerned with the amount of material that did not relate to their objectives; they wanted necessary information to be clearly delineated. Both groups wanted to be able to click on any structure on a screen instead of being limited to predetermined hotspots on a specific page. The PVM students expressed appreciation of QTVR for bones to visualize foramina, but some did not appreciate QTVR that illustrated muscles because specific muscles were not labeled. Both groups wanted information about other species, clinical applications, and programs for other sections in the course.

Surveys

Students gave the program a positive evaluation through the surveys. Both PVM and MS students gave high ratings to each of the seven categories. The students (1) showed positive attitudes toward the program and generally agreed that the program (2) met their needs, (3) helped them during dissection, (4) increased their confidence during dissection, (5) was appropriate, (6) helped them be more efficient, and (7) was easy to use.

Although both groups gave high ratings in all categories, significant differences were found on the category scores between the two cohorts of students. PVM students gave higher ratings for Category 2 (Needs met), Category 5 (Appropriate content), and Category 6 (Efficiency) than MS students (see Table 1). These results are not surprising. The program is more closely aligned with the PVM course objectives; the content on the program may not have met the MS students' needs as well as it met those of the PVM students. In addition, PVM students may have reported higher efficiency scores because the content was more aligned with their goals, thus helping them achieve their goals quickly. However, all of the MS students' mean responses from the differing questions were above 3, showing that they generally agreed that the program met their needs, was appropriate, and increased their efficiency.

Differing sample sizes and bias may also explain the significant differences between the two groups. The PVM students worked closely with the authors of the program, and these relationships may have influenced more positive responses toward the program. Differences between the two groups may also have stemmed from the difference in sample sizes: Nine MS students completed the survey, while 66 PVM students responded. The smaller sample size of the MS students affects the reliability of the results from this group.

No comparison was made between categories; thus the different number of questions in each category did not affect the study. In addition, the same survey questions were asked of both PVM and MS students, so different numbers of questions would not affect comparison of survey results between the two cohorts of students.

Test Scores

The program had no significant effect on the MS students' test scores.

These results were expected. The students were expected to learn the material regardless of their resources. The program was designed to help students learn the material more efficiently, allowing students and instructors to discuss higher-level topics during laboratory sessions, such as clinical applications. However, the course exams tended to focus mostly on lower-level topics such as identification; any changes in students' comprehension of higher-level topics would not be measured.

Observations

During laboratory sessions, students relied heavily on the program. Few students brought their textbooks to the laboratory. Students seemed self-directed, confident, and independent because instructors often approached students instead of vice versa. Instructors still received many identification questions, but they also had time to discuss higher-level issues. Students used the program during laboratory sessions for group and individual study. Students brought class objective handouts to determine which information in the program was applicable.

Variations in comfort levels with the program were obvious. Some instructors used the program to display certain structures to illustrate their points, while others did not. Some instructors also showed students how to maximize their use of the program (such as reviewing every structure shown on a screen before proceeding to the next), while others did not seem to know what features were available. Such variations were also apparent among students during the first laboratory, but by the second and third laboratory sessions most students realized the capabilities of the program and were using advanced features such as the search function.

Student efficiency increased, probably through use of the program. Students left the laboratory early, and many students did not come to the last laboratory period for the head section. Students expressed surprise when instructors

told them that previous classes had been rushed and unable to finish the head section.

FUTURE RESEARCH

Future research projects will examine whether the program has any effect on the quality of student–instructor interaction. We wish to assess whether the program decreases students' reliance on instructors for basic tasks, allowing students and instructors more time to discuss higher-level learning issues.

NOTES

a For screen shots from the program, please see <http://www.cvmbs.colostate.edu/vetneuro>.

b Equal variances were assumed on *t*-tests because a Levene's Test for Equality of Variances produced no significant results.

c A one-tailed test was used because it was hypothesized that the experimental group would perform better than the control group.

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