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ABSTRACT

This research examines the performance, achievement, and attitudinal effects of a dissection alternative, an interactive videodisc-based (IVD) simulation in two ways: as a substitute for dissection and as a preparatory tool used prior to dissection. Sixty-one high school students enrolled in three general ability high school biology classes participated in this research over a 4-day period. On the substitution issue, findings suggest that the IVD simulation was at least as effective as actual dissection in promoting student learning of frog anatomy and dissection procedures. On the preparation issue, it was found that students using the IVD simulation as a preparation performed a subsequent dissection more effectively than students receiving no preparation and more effectively than students viewing a videotape as preparation. Students using the IVD simulation as preparation also learned more about frog anatomy and dissection procedures than those who dissected without preparation. Students in all groups evidenced little change in attitudes towards dissection. All students reported a significant gain in dissection self-efficacy, but no between-group differences were found. Findings are discussed relative to their implications for educational practice and future research. Six tables containing results of a survey on student attitudes towards dissection, achievement, attitude, self-efficacy and dissection performance test scores, and analysis of variance results are appended. (Contains 16 references.) (Author/KRN)

Title:

The Effects of an Interactive Dissection Simulation on the Performance and Achievement of High School Biology Students

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The Effects of an Interactive Dissection Simulation on the Performance and Achievement of High School Biology Students

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ABSTRACT

Educators, administrators, and students are re-evaluating the value of animal dissection in the classroom and are taking a careful look at instructional alternatives. This research is an attempt to examine the performance, achievement, and attitudinal effects of a dissection alternative, an interactive videodisc-based (IVD) simulation, in two ways: as a substitute for dissection and as a preparatory tool used prior to dissection. Sixty-one high school students enrolled in three general ability high school biology classes participated in this research over a four day period. On the substitution issue, findings suggest that the IVD simulation was at least as effective as actual dissection in promoting student learning of frog anatomy and dissection procedures. On the preparation issue, it was found that students using the IVD simulation as a preparation performed a subsequent dissection more effectively than students receiving no preparation and more effectively than students viewing a videotape as preparation. Students using the IVD simulation as preparation also learned more about frog anatomy and dissection procedures than those who dissected without preparation. Students in all groups evidenced little change in attitudes towards dissection. All students reported a significant gain in dissection self-efficacy, but no between group differences were found. Findings are discussed relative to their implications for educational practice and future research.

The Effects of an Interactive Dissection Simulation on the Performance and Achievement of High School Biology Students

Frog dissection in our nation's high schools is widespread. It has been estimated that 75 to 80% of the country's four million biology students dissect frogs (Orlans, 1988a). As part of a growing controversy over the use of animals for dissection, some of these students are refusing to conduct dissections on moral grounds. Animal rights groups have developed student and educator outre... programs encouraging alternatives to dissection. Legislation has been passed in some states protecting the rights of students who do not wish to participate in dissection. Many educators contend, however, that there is merit in conducting dissections to assist students in learning about the anatomy and biological functioning of animals.

The research reported here is an attempt to examine the effects of a dissection alternative, a videodisc-based simulation, in two ways. First, because it is of interest to determine if such an alternative could be as effective a learning tool as actual dissection, the effects of the simulation were compared to those of an actual dissection. Relevant outcomes were student achievement on a test of frog anatomy and dissection procedures and dissection-related attitudes and self-efficacy. Second, because many educators believe in the value of dissection, the simulation was examined as a preparatory tool, used prior to dissection. Here the achievement, attitude, and self-efficacy scores were also employed, along with a measure of students' actual dissection performance. Comparisons were made between the following groups: (a) students receiving the interactive videodisc-based simulation as preparation, (b) students viewing a linear videotape (containing the same video images as the simulation but without the interactive practice) as preparation, and (c) students receiving no preparation.

In this paper, we briefly outline the controversy surrounding dissection. We go on to describe the design of the videodisc simulation, followed by a presentation of research methods and results. Finally, the results will be discussed with regard to their implications for educational practice and future research.

Origins of Dissection in the Biology Classroom and the Current Controversy

Animals have been dissected in biology classes since the early 1900's. According to Orlans (1988a) it is believed that dead frogs first became available from commercial suppliers between 1910 and 1920. Even though frog dissection was not included in the first formal biology textbook published in 1921, it had become an established laboratory activity in the nation's high schools by the 1920's. By the 1960's, frog dissection had become very popular as a result of the new biology curricula developed by the Biological Sciences Curriculum Study (BSCS) (Hairston, 1990). As mentioned previously, by 1988 it was estimated that 75 to 80% of this country's four million biology students were dissecting frogs (Orlans, 1988a).

In recent years animal dissection has come under increased scrutiny. As a result of several judicial and legislative decisions, students, teachers, and administrators are being compelled to re-evaluate the morality and instructional effectiveness of this use of animals. The California and Florida legislatures passed bills protecting the rights of students who do not wish to participate in dissection (Orlans, 1988a). Massachusetts considered similar legislation in 1990 (Smith, 1990).

Some science educators and scholars, such as Orlans (1988a, 1988b), advocate replacing the traditional dissection lab with the study of live organisms. Others, such as Berman (1984), Hoskins (1979), and Igelsrud (1986, 1987), express support for dissection. Their support, however, is conditional upon the use of great care and planning in the design of lessons using animal specimens.

The National Association of Biology Teachers (NABT) policy statement, "Animals in Biology Classrooms," recognizes the long history of animal dissection in biology education and the educational value of "well constructed dissection activities conducted by thoughtful instructors"

(Hairston, 1990, p. x.) Nevertheless, the NABT statement suggests that biology teachers reexamine their reasons for including animal dissection in their courses and consider using alternatives.

Currently available alternatives include books, charts, computer programs, models, filmstrips, slides, transparencies, videotapes, and videodiscs. Many of these, however, can be faulted for their lack of realism and opportunities for student involvement. Furthermore, little research has been conducted to evaluate their effectiveness. Film or video-based alternatives have the greatest potential to accurately depict the animal being studied since they show actual specimens. Results of research comparing the use of two film-based alternatives to actual dissection in medical and veterinary anatomy instruction suggest that such alternatives can be as effective as dissection in promoting cognitive outcomes (Prentice et al., 1977; Welser, 1969).

The Interactive Frog Dissection

Since the film-based dissection alternatives mentioned above were evaluated, interactive videodisc technology (IVD) has emerged as an instructional tool of great potential for instructional simulations. Iuppa (1984) defines interactive video as "any video system in which the sequence and selection of messages is determined by the user's response to the material" (p. 5). This feature, which allows learners to experience consequences to their decisions, is probably the most significant feature of IVD. IVD-based simulations take advantage of the medium's high quality audio and video, instant random access capability (any location on a videodisc can be accessed in two seconds or less), playback flexibility (e.g., variable speed and direction, different audio tracks depending on user performance), and storage capacity (up to 54,000 still images or 30 minutes full-motion video). These features are then coupled with a microcomputer's text, graphics, and videodisc control capabilities.

An IVD-based simulation of frog dissection, called The Interactive Frog Dissection was developed by Strauss and Kinzie (1991) as a research tool to study the potential of dissection alternatives. It includes demonstrations of frog dissection and depictions of frog anatomy interspersed with practice activities on dissection procedures and anatomical identification. Additional directions, explanations, and feedback are supplied in response to student input, ensuring a high degree of interactivity.

Results from pilot research suggest that students using The Interactive Frog Dissection learn as much about dissection procedures and frog anatomy as students conducting an actual dissection (Strauss & Kinzie, in press). The following study continues this investigation, comparing the achievement and attitudinal effects of the simulation to those of laboratory dissection, and extending the exploration to include the use of the simulation as a preparatory tool prior to dissection.

METHOD

Subjects:

Participating in this research were 61 students (33 male and 28 female) at a high school located near a small mid-Atlantic city. The participants were an average age of 15.30 (*SD* = 0.92) and were enrolled in three general ability biology classes taught by a single instructor. Seventy-seven percent (*n* = 47) reported participating in a previous dissection, all but one occurring in the seventh grade. The study was conducted over four consecutive days following a unit on human anatomy.

Procedures:

Students in each of the three classes were randomly assigned to one of four groups: (1) the IVD Prep group used the interactive videodisc-based simulation as a preparation for laboratory dissection (*n* =16); (2) the Video Prep group viewed a linear videotape containing the same video materials used in the IVD simulation, but without interactivity (*n* = 15); (3) the Diss Only group conducted the dissection without preparation (*n* = 15); and (4) the IVD Only group used the IVD simulation but did not dissect (*n* = 15). Within each group, students were randomly assigned to teams of two or three each. Preliminary analyses indicated that there were no significant between-group differences on the biology course grade earned prior to that point in the semester.

On the first day of the study, the teacher told the students that they would be helping to evaluate some instructional activities related to dissection. The teacher explained that because there were not enough computers for everyone to use them at once, they would be splitting up into groups, with different groups sometimes engaging in different activities. Students were also informed that everyone would have the opportunity to use the computers. (Even students whose instructional treatment did not include use of the computer-based simulation were given the opportunity to use the simulation after completion of data collection.) Students then completed the achievement pre-test and attitude and self-efficacy pre-measures. There were no significant differences between treatment groups on pretest achievement, attitude, or self-efficacy.

On day two, students in the IVD Prep group used the simulation, students in the Video Prep group viewed the videotape, and students in the Diss Only or IVD Only groups completed library research for an unrelated biology assignment. For their use of the simulation, students in the IVD Prep group broke into their randomly assigned teams (two teams per class period). Each team worked through the simulation at one of two IVD stations located in their classroom. IVD Prep students spent an average of 39.4 minutes (SD = 3.6) on the dissection simulation. Students in the Video Prep group went to a nearby classroom to view the videotape, which lasted 15 minutes. On completion of the videotape, the Video Prep students went to the library to work on an unrelated biology assignment.

During day three, student teams in the IVD Prep, Video Prep, or Diss Only groups completed a frog dissection laboratory at laboratory benches in their classroom. Students in the IVD Only group broke into their two teams and used the interactive videodisc-based simulation. The IVD stations were placed in corners of the classroom some distance a y from the laboratory benches and the other students. There was very little to no interaction between students conducting the dissection and students using the simulation. All students were engaged in their respective activities for the duration of the class period. On the fourth and final day, students in all groups completed the achievement post-test and the attitude and self-efficacy post-measure. Students were told that their grade on the posttest would count towards their course grade, so that they should try hard to do well. On day four, one student was absent and was dropped from all analyses involving any of the post-measures. Another student was called out of class during the posttest; this student was dropped from analyses involving the posttest.

Materials:

Students in the IVD Prep and IVD Only groups used the interactive videodisc-based simulation previously described. The videotape used in Video Prep treatment was taken from the simulation videodisc. It presents and reviews dissection procedures then presents and reviews frog anatomy, but differs from the IVD materials in that it does not provide opportunities for practice.

Student teams conducting the dissection on day three received a lab handout detailing dissection procedures through diagram and description. The dissection procedures parallel those presented in the IVD and Video materials. The lab handout instructed teams to locate various organs during the dissection. In teams with three students, one student selected the job of surgeon, another acted as assistant surgeon, and a director relayed instructions. In two-member teams, the assistant surgeon also relayed instructions.

Criterion Measures:

The 30-item achievement test was composed of several parts measur ıg knowledge of frog anatomy and dissection procedures. Part One provided three diagrams on which students were directed to find and label ten organs. During Part Two, students went one at a time to lab stations to examine four previously dissected frogs marked with 11 numbered pins. Students named the organs marked by the pins. In Part Three, students answered nine multiple choice questions (four response options each) about dissection procedures. Inter-item consistency reliability (KR_{20}) calculated from the post-test administered during this study was .58, suggesting some degree of heterogeneity in the content domain sampled.

The Attitudes Toward Dissection measure was constructed of 20 items with a four-point Likert-type response scale. Ten of the items were adapted from those used by Strauss & Kinzie (1992). Ten additional items were developed specifically for this research. Half of the items are positively phrased and half are negatively phrased, as described by Gable (1986). Before administration of this measure, it was reviewed and critiqued by six high school science teachers and six educational technologists, and subsequently revised. Inter-item consistency (Cronbach's alpha) of this instrument was calculated from the post-administration in this study; it is estimated to be .94. The Attitudes Toward Dissection measure is contained in the Table 1.

Insert Table 1 about here

The self-efficacy measure contains 25 items which elicit respondent confidence in performing various dissection procedures and confidence in identifying portions of frog anatomy. Students indicated their level of agreement on a four-point Likert scale to items beginning with "I feel confident..." and ending with phrases such as "pinning the muscle flaps to the tray," and "locating the gall bladder." Alpha reliability of this measure was calculated from student response to the post-administration during this study ($r_{tt} = .99$), and indicates a high level of internal consistency.

During the dissection laboratory, six student teams worked at six lab benches, three on each side of the classroom. Four researchers observed and evaluated dissection performance. The researchers were educators well-trained in dissection procedures. Two researchers observed on each side of the classroom using a 41 item checklist (Y/N) to evaluate team performance. Checklist items parallel dissection procedures outlined in the lab handout and preparatory materials. The checklist contains items such as, "Lifts muscle tissue with forceps?" and "Identify kidneys?" Teams who correctly performed a step in the dissection or successfully identified a specific organ were awarded a "Y" rating; those that did not received a "N;" all Y ratings yielded one point towards the overall evaluation score. In the event that a team was not performing a step properly or could not identify an organ, the researcher assisted by describing the appropriate technique or indicating the organ. Each researcher evaluated one team alone, and one team in consort with another researcher. This was to ensure reliability of the evaluation. In all cases, joint observation yielded congruent evaluation ratings.

Finally, four questions soliciting student preferences for various study activities were included at the end of the affective post-measures. Students were asked, "If you were given a choice of study activities in school, which would you prefer?" Students selected one choice from each of the following pairs: 1) Studying frog dissection and anatomy *or* studying another topic within biology; 2) Watching a videotape or film on dissection *or* using a computer program on dissection; 3) Using a computer program or watching a videotape or film on dissection *or* conducting an actual dissection; and 4) Conducting a dissection after using a computer program or after watching a videotape or film on dissection *or* conducting a dissection without using any prior instructional materials.

<u>Design</u>:

This study employed a pre-test/post-test design. One-way Analysis of Variance and Covariance (ANOVA, ANCOVA) procedures were employed, except where noted. All Analyses were completed with SPSS PC+ v. 3.0.

RESULTS

As shown in Table 2, all subjects evidenced significant gains in achievement test performance between the pretest (M = 10.05 out of 30 possible, SD = 3.96) and post-test (M = 21.24, SD = 4.76). Repeated Measures analysis indicates this overall gain to be significant, $F(1, 58) = 238.00$, $p<.0001$. Attitudes toward dissection remained relatively stable from day one (M = 50.89 out of 80 possible, SD = 11.42) to day four (M = 52.50, SD = 12.21). Self-efficacy with dissection procedures, on the other hand, increased from the administration of the pre-measure (M = 64.95 out of 100 possible, SD = 20.21) to completion of the post-measure (M = 72.73, SD = 20.44), $F(1, 58) = 17.01$, $p<.0001$.

Insert Table 2 about here

In the analyses that follow, premeasure scores are used as covariates in the examination of postmeasure scores. To begin, overall analyses were conducted on each measure. The outcomes indicated treatment effects for Achievement, (depicted in Table 3) and Dissection Performance (shown in Table 4). No treatment-related differences were suggested for Attitudes, Self-Efficacy, or Dissection Time. Teams required an average of 36.69 minutes overall (SD = 6.86) for the dissection. Planned comparisons were then conducted on Achievement and Dissection Performance.

Insert Tables 3 & 4 about here

Simulation versus Dissection

The first comparison contrasted subjects receiving the interactive videodisc-based simulation only (IVD only) with those conducting the dissection only (Diss Only). No achievement differences were found between the IVD only group (M_{gain}=10.00) and the Diss Only group (M_{gain}=7.87).

Interactive Simulation as Preparation

The second and third planned comparisons were directed to determine the relative efficacy of using the IVD-based dissection simulation as a preparation for students who will go on to conduct dissections. To examine the effects of the interactive simulation as preparation versus no preparation at all, IVD Prep subjects were compared to Diss Only subjects on both dissection performance and achievement. Next, to determine the relative effects of interactive practice during the dissection preparation, subjects in the IVD Prep group were compared to those in the Video Prep group, again examining dissection performance and achievement outcomes.

Dissection Performance. Subjects who used the dissection simulation as preparation for the actual dissection (IVD Prep, M = 38.94 out of 41 possible, SD = 2.08) were found to be more effective in conducting the dissection than those who had received no preparation (Diss Only, M = 32.21, SD = 4.53), $F(1,28) = 28.52$, $p<.0001$. The dissection simulation with its interactive practice activities also proved to be more effective than than linear videotape (Video Prep, M = 33.13, SD = 5.94) in preparing students to conduct dissections, $F(1,29) = 13.54$, $p<.001$. Table 5 contains the results of these Dissection Performance analyses.

Insert Table 5 about here

Achievement. Students given the IVD simulation as preparation (IVD Prep, M_{gain}=14.69) learned more than students not given any preparation prior to conducting a dissection (Diss Only, M_{gain}=7.87), $F(1,28) = 15.24$, $p<.001$. No difference in achievement was found between IVD Prep subjects and Video Prep subjects (M_{gain}=12.23). See Table 6 for the statistical summaries.

Insert Table 6 about here

The Value of Dissection after IVD Preparation

In the final planned comparison, students using the dissection simulation followed by actual dissection (IVD Prep) were compared to those using the simulation without dissection (IVD only). The intent was to determine the additive effects that actual dissection might have following use of the simulation. Statistical outcomes (see Table 6) suggest that the combination of the interactive dissection simulation and actual dissection (M_{gain}=14.69) was more effective in promoting overall achievement than the simulation alone (M_{gain}=10.00), $F(1,28) = 7.56$, $p<.01$.

Preferences for Study Activities

Multivariate analysis of variance (MANOVA) outcomes indicated no significant between-group differences at the multivariate level in subject preferences for study activities. Subjects were then pooled and their responses analyzed via the Chi Square test to determine if their expressed preferences were significantly different from those expected by chance (50%). Subjects reported a strong preference for dissection when preceded by some form of preparation (computer program, video, or film) (87%) over dissection without any such preparation (13%), χ^2 (1, N = 60) = 30.82, $p<.001$. Preferences were also expressed for use of a computer program on dissection (68%) over a related video of film (32%), χ^2 (1, N = 60) = 7.35, $p<.01$. No significant differences were noted between student preferences for use of a dissection substitute (computer program, video or film) and actual dissection, or between the study of dissection and anatomy and another topic within biology.

DISCUSSION

Achievement and Performance

Several interesting achievement outcomes were obtained in this research. First, an interactive dissection simulation was found to be at least as effective as actual dissection in promoting learning about frog anatomy and dissection procedures. This outcome supports the preliminary results reported by Strauss & Kinzie (1992) with the same dissection simulation, as well as outcomes reported by Prentice et al. (1977) and Welser (1969). At the least, these results suggest that effective alternatives can be offered to students or educators who desire other approaches to learning about vertebrate anatomy.

A second finding of note was the effectiveness of the interactive dissection simulation as preparation for actual dissection. Students using the simulation as preparation performed more effectively during the dissection than those who had received no preparation, and more effectively than students viewing a linear videotape as preparation. The differential effectiveness of student teams during actual dissection is not to be minimized--in a typical classroom containing 20 to 30 students, a single instructor is hard-pressed to lend assistance to all student teams conducting a dissection. In this study the four researchers present during the dissection laboratory were busy with only six dissection teams. Instructional preparation which can ensure student effectiveness in upcoming laboratory situations has indisputable value.

The performance advantage for the IVD Prep treatment tended to translate into an achievement benefit as well: students using the interactive simulation as preparation for the dissection learned more overall than students receiving no preparation. And as might be expected, following an instructional activity like the interactive videodisc-based dissection simulation with an actual dissection led to greater overall learning than use of the simulation alone.

It could be argued that the apparent advantage of the dissection simulation over the linear videotape was due not to the provision of interactive practice but rather to the time differential between the two treatments: IVD Prep subjects spent an average time of 39.4 minutes with the simulation; Video Prep subjects viewed the videotape for 15 minutes. However, since identical video materials were displayed in both treatments, the time differential was due solely to the interactive practice activities contained in the dissection simulation.

Attitudes and Self-Efficacy

That no significant changes were found in attitudes towards dissection is not surprising; theorists have long contended that affective values are relatively stable and are modified only over time

(Dick & Carey, 1990; Kerlinger, 1973). Self-efficacy with dissection procedures increased for all groups as a result of their activities, but no between-group differences were significant.

Preferences for Study Activities

Results of the Chi square analyses suggest the value that students perceive in appropriate preparation for dissection: 87% of the participants in this study indicated a preference for dissection when preceded by a computer program, videotape, or film on dissection while only 13% preferred a dissection without preparation. The results of these analyses also point to the attraction that computers may hold for individuals in this population--about two-thirds of the students expressed a preference for use of a computer-based program on dissection over a related video or film.

Recommendations for Educational Practice

As mentioned previously, findings reported here suggest the efficacy of providing a dissection simulation as an alternative to laboratory dissection. For those educators who do not have access to interactive videodisc hardware and software, other viable dissection alternatives exist (though they were not tested in this research): use of less sophisticated computer programs, activities involving anatomical models, and the study of live frogs in the classroom (Hairston, 1990).

However, use of such a simulation is not the equivalent of performing a laboratory dissection: students viewing frog specimens on a computer screen will not have the same sensory experience as students examining actual frog tissues and organs. They may not feel the same sense of personal discovery. For these reasons, some educators may prefer to include dissection laboratories in their biology classes. Results obtained here underline the importance of preparing students for the dissection experience. If possible this instructional preparation should include dissection-related practice activities. In this study, students who received interactive practice performed subsequent dissections much more effectively and required much less assistance than those who viewed a linear videotape as preparation or those receiving no preparation at all. The IVD preparation group also learned more than did the group conducting a dissection with no preparation. Students across groups expressed a preference for dissection when prepared by computer program, videotape, or film over dissection alone, and a preference for use of computer programs as preparation over videotape or films for the same purpose.

Finally, following up an activity like the dissection simulation with actual dissection may lead to increased learning over use of the simulation alone. It should be noted, however, that alternative learning activities besides dissection could be considered as valuable follow-up activities. It is conceivable that the achievement benefit found for the simulation plus dissection could also be found for the simulation followed by any number of other activities focusing on frog anatomy.

Recommendations for Future Research

Among the research possibilities in this area are explorations involving the various dissection alternatives that exist. What is their potential relative to laboratory dissection to enhance student learning? Could a dissection simulation be followed up by other activities besides dissection for achievement gains similar to those found here? Through research projects such as these, we can better define the attributes of instructional activities having the most educational potential for biology classrooms.

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Table 1

ATTITUDES TOWARD DISSECTION Measure

SURVEY: HOW DO YOU FEEL ABOUT DISSECTION?

This survey has 20 statements about the use of dissection for educational purposes. After reading each statement, please indicate the extent to which you agree or disagree, by circling the number to the right of each statement. Please respond to all statements. There are no correct or incorrect responses.

		I Strongly Disagree	I Disagree	I Agree	I Strongly Agree
1.	I don't see how frog dissection will help me to learn about frog anatomy.	1	2	3	4
2.	Animals can be treated with respect in a dissection.	1	2	3	4
3.	Dissection is an unpleasant activity.	1	2	3	4
4.	Biology students should dissect an animal to help them learn about anatomy.	1	2	3	4
5.	I am disturbed by the idea of dissecting an animal.	1	2	3	4
6.	Dissection makes biology more interesting.	1	2	3	4
7.	Dissection is not a useful way to learn about the structure and function of animals.	1	2	3	4
8.	It is morally acceptable for man to harm or destroy animals for education and research.	1	2	3	4
9.	I believe dissection is an effective way to study the anatomy of an animal.	1	2	3	4
10.	I feel comfortable with the idea of conducting a dissection.	1	2	3	4
11.	To help me learn about anatomy, there are more practical activities than dissection.	1	2	3	4
12.	Animals should not be harmed for the purposes of education and research.	1	2	3	4
13.	Learning about frog anatomy through dissection will help me to learn about the anatomy of other organisms.	1	2	3	4
14.	I do not think that learning about frog dissection will be useful.	1	2	3	4
15.	Dissection increases my respect for animals.	1	2	3	4
16.	My biology class would be more enjoyable without dissection.	1	2	3	4
17.	I feel okay about dissecting a frog in order to learn about frog anatomy.	1	2	3	4
18.	It is not very interesting to conduct a dissection and learn about frog anatomy.	1	2	3	4
19.	The study of anatomy does not justify the dissection of a biological organism.	1	2	3	4
20.	I am interested in finding out first-hand about frog anatomy through dissection.	1	2	3	4

Table 2

Mean Achievement, Attitude, Self-Efficacy, and Performance Scores

Group	n	Achievement Pre	Achievement Post	Attitudes Pre	Attitudes Post	Self-Efficacy Pre	Self-Efficacy Post	Dissection Perf
Entire Group	61							
M		10.05[a]	21.24	50.89[b]	52.50	64.95[c]	72.73	34.91[de]
SD		3.96	4.76	11.42	12.21	20.21	20.44	5.30
IVD Prep	16							
M		8.81	23.50	50.56	53.69	72.56	79.00	38.94
SD		2.29	2.90	10.42	10.40	17.87	15.54	2.08
Video Prep	15							
M		10.33	22.46	49.60	53.14	61.87	74.36	33.13
SD		5.22	4.88	12.60	11.22	18.64	18.27	5.94
Diss Only	15							
M		10.73	18.60	52.93	53.67	60.87	69.27	32.21
SD		4.13	5.53	9.84	14.08	21.46	24.66	4.53
IVD Only	15							
M		10.40	20.40	50.47	49.47	63.93	68.00	-
SD		3.83	4.32	13.42	13.55	22.63	22.37	-

[a] Total Score, out of 30 possible.
[b] Total Score, out of 80 possible. Higher Scores indicate more positive attitudes towards dissection.
[c] Total Score, out of 100 possible. Higher Scores indicate greater levels of perceived self-efficacy with dissection procedures
[d] Total Score, out of 41 possible.
[e] Mean Dissection Performance Score for the Entire Group excludes IVD Only subjects, who did not conduct the dissection.

Table 3

ANCOVA Outcomes for all Treatment Groups on Achievement

Source	SS	df	MS	F
Pretest[a]	46.78	1	46.78	2.50
Treatment	258.88	3	86.29	4.61**
Error	1011.02	54	18.72	

[a] Pre-measures were employed as covariates in all ANCOVA procedures.
** $p < .01$

Table 4

ANOVA Outcomes for all Groups on Dissection Performance[a]

Source	SS	df	MS	F
Treatment	408.62	2	204.31	10.40***
Error	825.03	42	19.64	

[a] Includes only those groups that conducted a dissection.
*** $p < .001$

Table 5

ANOVA Outcomes for Planned Comparisons on Dissection Performance

IVD Prep vs. Diss Only

Source	SS	df	MS	F
Treatment	337.50	1	337.50	28.52****
Error	331.30	28	11.83	

IVD Prep vs. Video Prep

Source	SS	df	MS	F
Treatment	260.81	1	260.81	13.54***
Error	558.67	29	19.26	

*** $p < .001$
**** $p < .0001$

Table 6

ANCOVA Outcomes for Planned Comparisons on Achievement

IVD Prep vs. Diss Only

Source	SS	df	MS	F
Pretest[a]	28.35	1	28.35	1.72
Treatment	250.64	1	250.64	15.24***
Error	460.49	28	16.45	

IVD Prep vs. Video Prep

Source	SS	df	MS	F
Pretest	1.98	1	1.98	0.13
Treatment	9.53	1	9.53	0.61
Error	407.46	26	15.67	

IVD Prep vs. IVD Only

Source	SS	df	MS	F
Pretest	11.08	1	11.08	0.87
Treatment	95.83	1	95.83	7.56**
Error	355.09	28	12.68	

a The Achievement Pretest served as covariate in these ANCOVA procedures.
** $p < .01$
*** $p < .001$