Running head: THE DISSECTION DILEMMA

The Dissection Dilemma: Real Dissection versus Virtual Dissection in a Middle School Classroom

Casey Boothby

Northwest Nazarene University

Abstract

A global awareness of the dangers facing our world and the potential destruction of thousands of species has prompted science teachers to look for alternatives to physical animal dissections in the classroom. This study examines the effects of a simulated dissection program (V-Frog) versus an actual frog dissection when measuring student achievement on a pre- and post-test. Results indicate that at the .05 level (p = .05) students scored statistically higher on the post-test when they participated in the simulated dissection program. It should be noted that students who participated in the actual dissection also increased their scores. Variables discussed include, the type of pre and post test as well as the time taken on both sessions. Though the data is promising, more research is needed to determine effectiveness of the virtual program to determine student knowledge of body systems.

Introduction

With the introduction of technology into the education system, there is a growing dilemma in the realm of science education. A global awareness of the dangers facing our world and the potential destruction of thousands of species has prompted science teachers to look for alternatives to physical animal dissections in the classroom. According to Lockard and Marszalek (1999), the problem facing biology teachers is to find an alternative means of instructional delivery that would yield substantially the same cognitive knowledge development in the students and help address the declining frog population. Dissection has also been a very controversial topic due to the destruction of helpless animals for the benefit of human understanding. At issue is the fact that students generally learn more when they are conducting hands-on experiments such as animal dissections. The manipulation of variables within an experiment and observation of the results helps students gain a better understanding of the subject at hand.

The technology introduced today has both advantages and drawbacks. With the Internet's capabilities, we are able to connect anywhere in the world within seconds and have access to an unlimited amount of information at our fingertips. However, with the availability of virtual worlds, internet sites, and interactive models and charts, there still lacks a vision of reality in each. A few studies have faulted the current alternatives for limited opportunities for active student participation (Strauss & Kinzie, 1991, Lockard & Marszalek, 1999).

Problem of the Study

The availability of virtual dissections both on the Internet as well as commercially indicates that the education world is moving towards the integration of technology into scientific dissections. The research, however, doesn't address whether or not these virtual dissection models positively impact the cognitive development of students who participate. The teacher also plays a large role in the success of virtual dissections and research reveals even less in regards to the teacher's attitude towards the implementation of technology into the classroom to impact student's cognitive development.

The researcher will address one main question with the implementation of this study. The researcher will determine if a virtual dissection positively impacts the cognitive development of students as much or more than a real world dissection. It is the hypothesis of the researcher that there will be no difference in the cognitive development of students as measured by a written posttest when students are exposed to a virtual dissection versus a real world dissection.

Literature Review

Research consistently shows that the constructivist theory of educational learning, where students connect prior knowledge and their own previous interpretations to their current learning has been very successful in the science education realm (Akcay & Yager, 2008; Kolodner, 2002; Barshinger & Ray, 1998). . There is a problem with the costs associated with integrating a virtual dissection program as well as the infrastructure required and personnel needed. Not everyone feels comfortable with technology and most any science teacher is used to real world dissections. The challenge is taking the constructivist educational theory and integrating it into the technology available (but sometimes costly) so that students have real experiences through simulations.

One particular study of interest used a computer simulation before the actual dissection and measured student's ability to learn anatomy compared to students conducting only the actual dissection. Akpan and Andre (2001) found that the simulation of a frog dissection provided before an actual dissection functioned as a conceptual model that allowed students to better understand and encode the dissection presented information. It also showed that students who participated in a simulation only scored better on their posttest than students who conducted a real world dissection or a simulation after a dissection. This study supports the use of virtual dissections as tools to improve student learning.

The above study provides support for another study which measured student's cognitive outcomes when using a two-way audio/visual interactive learning visit. Barshinger & Ray (1998) found that using any type of advanced organizer will have some positive cognitive and/or affective outcome. This audio/visual link provided an opportunity for feedback with the students and the museum workers that would normally would not have been available. The students in the study enjoyed going to the museum even more after the audio/visual link because they could go and do what they had seen on a television. This study supports the idea of an audio/visual link (in this researcher's case – a virtual dissection) to improve student learning and understanding of key concepts.

Another study which looked at frog dissections was done by Marszalek & Lockard (1999) and examined whether a conventional frog dissection, CD Tutorial, or Microworld helped students attain long-term retention of frog internal anatomy. They found that in most cases the three treatments yielded the same results with no difference in long-term retention. This case demonstrates that technology may not always be beneficial to the students and may actually cause more anxiety within the student population.

In a study conducted by Yager & Akcay (2008), the researchers compared the use of a more interactive approach to learning (STS approach) versus a textbook dominated approach. They found that though there were no differences in learning between the groups of students, the students who took part in the STS approach could describe and take concepts out into new contexts with higher success than the students who relied heavily on the textbook. This study suggests that any type of interactive approach to learning can lead to better cognitive connections and an improved degree of flexibility of learning with students.

Thomas & Hooper (1991) explain, "The literature on computer based instructional simulations is filled with contradictions concerning their use and effectiveness (p.1)." In their paper, Thomas & Hooper (1991) classified and analyzed simulations according to the function for which the simulation was used. Their analysis concluded that, "simulations are more effective when used before or after formal instruction, the effects of simulations are not revealed by tests of knowledge but are revealed by tests of transfer and application, and extensive research is needed on simulation design and use"(pg. 507). From their analysis, the researcher intends to thoughtfully choose a simulation that meets some if not all of their conclusions.

Janet Kolodner (2002) conducted a study in which she implemented technology and inquiry into science education by designing a program called Learning By Design. This approach took students to another level of learning and instead of reading the text, they participated in model building and problem solving to improve their learning. She suggests that by using this approach that students will be able to learn tasks and apply what they have learned across varying contexts. This is yet another paper that supports the movement from textbook based learning into interactive technologies and applications to improve student learning.

Alhalabi, Hamza, Hsu, & Anandapuram (1999) conducted a study in which they measured how successful students were at completing real laboratory experiments over the Internet without being in an actual laboratory. They found numerous problems with the software, the availability of resources online and meaningful student participation. According to the authors, “simulation software introduces an element of fiction; at best, it might only produce an approximation that may yield erroneous results (p. 4).”   The limitations of software actually restrict student freedom to complete the lab experiments as they would in real life. Students cannot freely explore in most computer simulations as they are designed for input and outcome based situations. When looking at available online laboratories, the authors struggled with finding any that were effective and useful for their research. The previous two problems lead to the final problem of student participation. Students could not meaningfully participate in these laboratory simulations because of the limitations of the software as well as the availability of resources.

In the article, “Science Education That Makes Sense” (2007), the American Educational Research Association indicated that visualizations help students learn processes better than using text. Their research shows that students gain insights when they use visualizations to link situations. This researcher considers virtual dissections to be a visualization technology and hopes to utilize it as suggested by the American Educational Research Association to improve student learning.

The costs involved in implementing new technology can also be a struggle within school districts. A quick search online for virtual dissection programs gleaned programs ranging in price from $300 to $1,000 for an all-building site license per year. This cost is above and beyond the cost of computers or computer labs to be equipped with the programs. As seen in Sonja Wiley-Patton's paper (1997) regarding Hawaii's Electronic School Project, the challenges may be too much for even a state to explore. The struggles noted in this paper included not enough man power, money, and strategic planning (p. 306). Not all schools have computers or computer labs and those in charge may not feel comfortable with new technology.

Studies show that teacher's perceptions and experiences with technology also influence the success of the technology used. Teachers traditionally take two roles when technology is introduced into the classroom. They either run from the technology because it is not what they use in their teaching practices or they embrace it fully or try to integrate it into every aspect of their teaching. Two studies of interest in regards to the teacher's role in technology are addressed in the next few paragraphs.

Kim, Grabowski, & Song (2003) imply in their results that the successful integration of an innovative learning program with the use of technology may depend greatly on how teachers relate what they have believed about their own teaching practices to new teaching approaches. It is extremely hard for teachers to change how they have taught, especially if they have taught for a number of years. This may actually hinder the success of the technology integration into the classroom.

The teacher's perceived role in the technology can also be a hindering factor. According to Yang (2002), "with appropriate strategies, laptops can be used as cognitive tools and they can enhance the possibility of shifting the teacher's role from lecturer to facilitator (p.5)." A teacher's role must change in order for the use of technology to be beneficial to students. It is the goal of the researcher in this study to be a facilitator for the students during the virtual and real world dissections. This will minimize the influence of the researcher and allow the study to measure only the variables it wishes to measure.

Methodology

In this quantitative study, the participants are approximately 135 students ranging in age from 12-14, enrolled in one seventh grade life science course in a mid-size western Idaho middle school of 800 students. These students had no prior experience in actual animal dissection or in the use of a simulated dissection. These students participated in the study as part of a normally scheduled laboratory involving frog dissection. Because it was a regularly scheduled class activity, all students in the classes participated in the activity. Data, however, were used only for those students that completed both the pre- and post- test during the sessions. Of the 135 eligible students in the participating teachers' sections, 13 were absent during at least one of the experimental sessions due to illness or other reasons. These factors reduced the total number from 135 participants to 122 students. To maintain student confidentiality, all data were coded with 6 digit identification number rather than student names.

Variables

The dependent variable in this experiment is the student's test scores in each experimental condition. The independent variable is the experimental condition itself, whether the students conducted a simulated dissection or an actual dissection. A confounding variable is whether or not students opt out of either experimental condition. We will be conducting nonprobability sampling for this experiment and the measurement instrument will consist of examining performance scores for each experimental condition.

Design

Participants were unsystematically assigned to the periods and teachers at the beginning of the academic school year in a manner so as to roughly equalize ability across sections. In this study, three class sections were assigned the dissection experimental condition while the remaining three class sections were assigned the simulation experimental condition.

Simulation sessions

The simulation session was conducted as follows. One researcher was present in the simulation session. Students met during regular class times in the regular science classroom. Laptops were brought into the classroom and were pre-loaded with the required program to complete the experiment. The participants were seated in groups of two at their classroom desks. The participants were introduced to the computer simulation by the instructor. The same instructor introduced the computer simulation to each section to ensure consistency during the experiment. Students were led through an initial introduction of the program and its features via a specific module in the computer program. They were then provided the opportunity to conduct the virtual dissections through individual modules that allowed virtual manipulation of a frog specimen. They could move to any series of modules at any time and were not constrained to complete the dissection in any particular order.

Dissection sessions

In the dissection laboratory, students worked at one lab table side by side in the regular science classroom. One researcher was present during the dissection sessions. The students were also led through an initial introduction of the dissection. These students were given the same materials via paper copies that the simulation sessions were given to ensure consistency during the experiment. When a student was not able to perform an assigned step or could not remove an organ, the researcher assisted the student after the finished dissection products had been evaluated. Due to the nature of a real animal, the students were required to complete specific steps with the dissection in order to see the appropriate body systems.

Students used their student numbers as identification during the experiment. The researcher worked with a total of 122 students and collected data based only on those student numbers. The students took a pretest to determine level of knowledge regarding body systems and dissections. The pretest was taken by all students who attended school on the first day of dissections. The achievement posttest (exact same test as pretest) was administered in the regular classroom three days after both experimental conditions were completed. The pre- and posttests consisted of identification of organs through diagrams, multiple choice questions, and proper labeling of a figure. The posttest was graded by the researcher with no other persons present so as to protect the integrity of the experiment and the confidentiality of the students. Students who missed one or both tests during the research period, regardless of participation in the dissection or simulation, were eliminated from the study. Data was stored in an Excel spreadsheet on a computer only accessible to administrators and the researcher.

Results

As can be seen from Figure 1 below; the students that completed the simulation session gained an average of 10.96 points from their pre- to post test scores. The dissection session students also gained but at an average of 8.45 points from the pre- to post test scores. A statistically higher average in test results was shown by the students who participated in the simulation versus the dissection of a real frog.

Figure 1 – Session Averages

	Simulation Session			**Dissection Session**		
	Pre	**Post**	**Gain**	**Pre**	**Post**	**Gain**
AVERAGES:	25.47	36.44	10.96	24.33	32.78	8.45

To further assess the validity of the experiment, a t-test: two sample assuming unequal variances was run using the data. At the .05 level ($p = .05$), a statistically significant result was found. In Figure 2 below, the critical value for a one-tail test was 1.66. Our attained value was slightly lower at 1.64. The increase in score for the simulation sessions was found to be statistically significant at the .05 level but not the .10 level.

Figure 2 – t-Test Results

t-Test: Two-Sample Assuming Unequal Variances

	Virtual Diss.	*Real Diss.*
Mean	10.96	8.45
Variance	58.41	74.71
Observations	55	58
Hypothesized Mean Difference	0	
df	110	
t Stat	1.64	
P(T<=t) one-tail	0.05	
t Critical one-tail	1.66	
P(T<=t) two-tail	0.10	
t Critical two-tail	1.98	

Discussion

The results above indicate that though there is not definitive evidence of a correlation between student's scores and the method of dissection they choose, the data does suggest there is strong evidence to support an increase in student learning through simulated dissections over actual frog dissections. More research needs to be conducted to determine the effectiveness of the virtual dissection. The researcher plans on continuing the study through the next few years to determine effectiveness across different classes and groups of students.

Initial data indicates that the simulation dissection is a great basic teaching tool for middle school students and can be readily used to increase student learning about basic body systems. However, the researcher questions whether this type of program would be effective in higher level biology courses. For example, a virtual dissection of a cadaver for a medical student would not be the ideal situation as they will one day be working with real humans and need the experience of working with the human body.

Though the data suggests statistically significant evidence for rejecting our null hypothesis, there needs to be discussion regarding changes and adjustments that need to be made to the existing experiment. The following are notes or suggestions for improvement on the existing experiment. If the researcher chooses to continue with the research, changes are vital to the success and validity of the data.

It should be noted that the pre- and post-test were derived from the virtual dissection program. Though not entirely from the program itself, the majority of the figures and questions came from a review program included with the virtual dissection program. This could be cause for discrepancy with the results since the simulation students had, in some shape or form, seen the diagrams and were accustomed to the views of the simulation program. The dissection students had not seen such diagrams though every effort was made to disseminate the same information to both groups.

It should also be noted that the time required completing the simulation sessions was significantly less than the time required to complete the dissection sessions. This time difference allowed the students who were in the simulation group to go back and review the material constantly. Since they were able to go back through the simulation any number of times they were given the opportunity to visualize body systems and parts of the frog that the dissection sections could not. The dissection students had only enough time to complete the dissection as directed before the post-test was administered. They also were instructed to remove and dispose of body systems they had cut out of the real frog. This did not allow the dissection students to review body systems they had covered in previous days.

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