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Bioscene: Journal of College Biology Teaching

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Using Independent Research Projects to Foster Learning in the Comparative Vertebrate Anatomy Laboratory

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Abstract: This paper presents a teaching methodology involving an independent research project component for use in undergraduate Comparative Vertebrate Anatomy laboratory courses. The proposed project introduces cooperative, active learning in a research context to comparative vertebrate anatomy. This project involves pairs or groups of three students testing a hypothesis concerning variation of an anatomical feature among vertebrates and an oral or poster presentation that reports the results. The project requires both examination of anatomical descriptions in scientific literature and direct anatomical investigation of vertebrate specimens available in the laboratory. This project component has been used successfully at two schools, where it has increased student enthusiasm for the discipline, increased student interpretive skills, and better placed the course material within the context of science. Both faculty and student perceptions of the successes and difficulties of such a project are presented.

Keywords: vertebrate anatomy, active learning, cooperative learning, problem-solving, inquiry, research, hypothesis testing

The emphasis in undergraduate science education has shifted to active learning, cooperative learning, and problem solving (National Science Foundation, 1996; National Research Council, 2000; Carin and Bass, 2001; Miller et al., 2002). Ways to integrate these kinds of learning into collegiate laboratory courses in the more explicitly experimental branches of biology are usually more obvious. However, laboratory courses in disciplines such as anatomy traditionally focus on the memorization of names of structures, relationships among structures, and acquisition of dissection skills. This traditional emphasis makes ways to involve student inquiry less intuitively obvious.

Courses in comparative vertebrate anatomy are often difficult to teach because the material requires that students learn a complex terminology that is used in a variety of contexts (e.g., phylogenetic, functional, developmental). These contextual perspectives are critical if students are to understand vertebrate anatomy as a science and not simply a litany of names. This extensive anatomical terminology in anatomy courses, also leads students to consider vertebrate anatomy to be a biological field that is so well known that it is “beyond” active research and inquiry.

Suggestions have been proposed for increasing the problem-solving and deductive reasoning involved in human and comparative anatomy laboratories using

investigative exercises (Chang, 2000; Koprowski and Perigo, 2000), clinical case studies (Cliff and Curtin, 2000; Peplow, 1998), brainstorming (Geuna and Giacobini-Robecchi, 2002), and model building (Shigeoka et al., 2000). These strategies are useful in providing both a context for the knowledge attained in the course and developing problem-solving skills. However, in addition to helping students learn the material we also were interested in linking laboratory activities directly to the research experiences that sustain the discipline and provide students with a sense of personal ownership that has been shown to increase retention of content (Clark et al., 2000). Contrary to student perceptions, comparative vertebrate anatomy is very much a field of active research in which students can verify or nullify hypotheses through direct observations.

This paper presents a teaching methodology involving an independent research project component for use in undergraduate Comparative Vertebrate Anatomy laboratory courses. This project component has been used successfully at two schools, Emory and Henry College and Regis University, and both faculty and student perceptions of the successes and difficulties of project are presented. Two authors are faculty members (M.J.G. and C.F.) and one currently is a student who has taken the course (D.J.L.).

INDEPENDENT PROJECT METHODOLOGY

Overview

This project involves pairs or groups of three students testing a hypothesis concerning the variation in an anatomical feature among vertebrates and an oral or poster presentation that reports the results. Allowing students to work in pairs or groups provides students with a collaborative learning experience and reduces

the workload of this demanding project on each student. The project is not simply a literature review and requires both examination of anatomical descriptions in scientific literature and direct anatomical investigation of vertebrate specimens available in the laboratory.

Selecting and Refining a Hypothesis

Early in the semester students begin by selecting an anatomical structure in which they have some interest. Students may choose any structure that is feasible to study within the limits of the facilities and specimens available, which is not explored in significant detail in lecture or laboratory. In discussing topics with students, telling them to pay some attention to function (or at least function as inferred from anatomical structure) likely will be helpful. The functional connection is especially important for structures such as muscles for which function can be clearly inferred from structure.

Once students select a structure, they propose a functional or evolutionary hypothesis to test. The hypothesis or question must be based on the students' knowledge of vertebrate relationships and anatomy, which will be somewhat limited early in the course. The instructor should help students develop clear hypotheses that can be tested with the specimens available for student examination. A proposed hypothesis could suggest that a structure will vary based solely upon function, based solely upon ancestry, or based upon some combination of the two. Hypotheses concerning development of structures typically are not reasonable given the specimens typically available. Students are encouraged to develop a more general hypothesis at the start that can be refined based upon some preliminary examination of specimens. (See Table 1.)

Table 1. Initial student hypotheses and the refined hypotheses developed after examination of specimens and the primary literature.

Initial Hypothesis	Refined Hypothesis
More active vertebrates will have more extensive coronary blood vessels.	Endothermic vertebrates, which typically have more active lifestyles, will have more extensive coronary vasculature and thus rely less upon oxygen from blood in the heart lumen than ectothermic vertebrates.
Tetrapod vertebrates that use their forelimbs for manipulation of objects will have more complex muscles in the forelimb.	Tetrapod vertebrates that typically move their manus with greater precision will have a more complexly divided forelimb musculature and these muscles will have longer tendons connecting to insertion points on the manus.
The ligaments supporting the liver in vertebrates will be most similar in closely related vertebrates regardless of how the vertebrates move.	Similarity in the position, number, and extent of hepatic ligaments in vertebrates will be similar among more closely related vertebrates and will not correlate with the type of locomotion utilized by the animal.

As in any scientific study, students need to begin by looking into what already exists in the published literature. Literature work should begin early in the semester when specimens in the laboratory are not yet ready for dissection. To introduce students gradually into the primary literature, they can start with the lecture textbook and laboratory manual. If the structure(s) being studied by the students is not mentioned, then students read about any associated structures. After reading what is available in course materials, students continue their research in the library. Instructors can facilitate this process by placing some relevant works on reserve. It is important to let the students know that, unlike in some other areas of biology that employ rapidly changing techniques, the publication date of sources is not as important a concern in anatomy. Gross descriptions of anatomy from the 1800s and early 1900s likely still will be useful and relevant. However, it is helpful to warn students that some older sources give different names to structures based on past naming conventions or older hypotheses of homology. We expect that students get their data concerning human anatomy from the literature since we did not have access to a cadaver lab at either of our schools and the literature on human anatomy is extensive. Readings in the scientific literature should help students begin the process of refining their hypotheses. Requiring that students turn in preliminary hypotheses with an annotated bibliography to the instructor for grading early in the semester helps ensure student complete the projects before the end of the semester.

In general, functional hypotheses will require students to do some research on the function or physiology of the organism or structure to be studied. For example, a study exploring the hypothesis that the liver will be more complexly lobed in endothermic organisms requires that students know about and can categorize the thermal physiology of all the specimens examined. Students would need to know, not only that birds and mammals are endothermic, but that birds usually have higher metabolic rates and body temperatures than mammals and also that turtles, lizards, snakes, and crocodylians typically have a higher metabolic rate and usually maintain body temperature higher than amphibians.

Initial Explorations

A benefit of independent projects is that it makes it obvious to students that science in practice is a dynamic endeavor based on data. Students need to be encouraged to examine specimens as early as reasonably possible to start refining their hypotheses and determine if their hypotheses are testable based on the gross anatomical data that they can reasonably collect. It is often difficult to convince students to simply begin cursory examination of specimens and not begin an in-depth examination at the start as one

might run a series of planned experiments. This initial series of examinations is much like requiring students to perform a trial run of an experiment in molecular biology to refine the methods and ensure that the study is feasible (i.e., ensure that structures are visible, variable, and reasonable to examine given the methods available).

Students also need to determine which specimens they should examine. The best answer to the question “how many do I need to look at?” is “As many as you possibly can.” However, the anatomical structures of some organisms will be more important in addressing the hypothesis. If the student’s hypothesis concerns the correlation of a type of structure with a specific function, then the implication is that the similarity is due to function **NOT** due to ancestry. Therefore, finding two or more members of a closely related group that have differing function will be important data to use for supporting or rejecting the hypothesis. Conversely, if the student hypothesis concerns the correlation of a type of structure with ancestry, not with function, examining a range of organisms with different degrees of relatedness and different function would be needed for supporting or rejecting the hypothesis.

Gathering Data

The gathering of data takes a significant amount of time and we arranged for students to have access to the laboratories outside of the class period. Students need to examine as many species and individuals as possible. Any hypothesis about anatomical evolution requires examination of more animals to be reasonably supported (or rejected). It is a good idea to remind students that anatomical structures often vary within species. Looking at a single cat does not necessarily provide a good base of knowledge concerning the anatomy of this species. We required student to keep a lab notebook for gathering data including sketches and prose descriptions. Students were told to specifically do the following:

- 1) describe the features of your structure that are relevant to the hypothesis being tested. It is not uncommon for students to have to re-examine specimens after looking at other specimens. Anatomists’ perspectives often change after observing how a structure varies.
- 2) measure each specimen’s size using standard anatomical measurements
- 3) identify each specimen's sex and its reproductive condition, sexual maturity or what stage of sexual activity it is at (e.g., pre-spawning female with ovary full of ova).
- 4) indicate the anatomical preparation and preservation of each specimen (e.g., double injected and preserved in Carosafe™).

- 5) indicate any individual peculiarities of each specimen, such as any damage or inferred pathology.

Students need to be cautioned that when dissecting specimens they must do as little damage as possible. If students need to dissect a bilateral structure, then they should be instructed to dissect only one side leaving the other intact. For reasons of economy and responsible use of specimens, we had each specimen examined by all the students who are studying its various anatomical features and required that students discuss any removal or destructive dissection with the instructor before proceeding.

DRAWING CONCLUSIONS

Students then need to interpret their many observations both to address their hypotheses and to generally understand what they have observed. We suggested the following to students.

1. Arrange rough drawings, descriptions, or summaries of the organs or structures of various organisms in a table with organisms grouped taxonomically.
2. Arrange rough drawings or very short descriptions of the variable organ or structure along the top of the phylogenetic tree provided in class.
3. Arrange rough drawings, descriptions, or summaries of the organs or structures in various organisms in a table with organisms grouped based on pertinent qualities mentioned in your hypothesis. (Physiology, Diet, Function, etc.)
4. Consider what anatomy would be intermediate between the anatomical forms you saw in the species you examined. Would these intermediates be functional?
5. Consider how each type of organ or structure would develop.
6. Consider the natural history/ecology of the organisms examined and how that natural history would affect the functioning of the organ or structure.
7. Remember that the flexibility, texture, and especially the color of structures can be altered by the method of preservation and injection used.

Students can then use their data to support or reject their hypotheses. Students should be reminded that a single conflicting datum is enough to reject a hypothesis.

PRESENTING RESULTS

Students should present their results in some format to the class. This allows students to see what other students have learned and provides a real impetus for students to synthesize what they have learned. We have used both scientific poster sessions and talks

involving visual aids. In both cases students are expected to answer questions about their research. The requirement that two (or more) students work together gathering data and producing a final presentation fosters the development of group skills and takes some of the pressure of the presentation off individuals. Opening the final presentation session to the academic and outside community gives the students a chance to illustrate their accomplishments and provides another incentive to take the whole process seriously. A digital camera is particularly useful, but not absolutely necessary, in allowing students to clearly show the structures they studied without spending a large amount of time illustrating.

PROJECT BENEFITS

Direct Project Benefits

A direct benefit of this type of project is that students come to understand one anatomical system in significant depth. The volume of material that is typically covered in a comparative vertebrate anatomy course means that students do not usually develop a comprehensive understanding of any single anatomical structure. This project provides students with some understanding of the overall complexity of vertebrate anatomy. Occasionally, students even identified errors or omissions in dissection guides. Independent-inquiry based projects in this instance and others clearly provide students with a sense of ownership of the material (Davis, 2002). A substantial benefit is the level of pride that the students take in their primary knowledge of “their” structure that has been shown to increase student retention of material (Clark et al., 2000; Rao and DiCarlo, 2001).

The project provides students with anatomical skills in dissection and examination of specimens. Repeated manipulation and examination of specimens result in students being more comfortable dealing with vertebrate tissues and organs. Students beginning the project may have trouble seeing variation or finding “their” structures. However, by the end of the project they are comfortable with the dissection and are able to recognize the types of variation that are anatomically significant.

Indirect Project Benefits

One of the most satisfying benefits of the project is the realization by students that anatomical inquiry is a science based on observation that can support or reject hypotheses. Students also quickly realize that dissection manuals are not the final authorities and that there is much that currently is not known about the anatomy of vertebrates. By directing their research projects to areas of interest, students also became aware that vertebrate anatomy is relevant outside of the classroom. For example, students interested in pursuing graduate work in physical therapy chose studies of muscle or ligament variation.

As in most independent projects in courses, students developed an intimate understanding of how scientific inquiry proceeds. However, a particular benefit to this approach in a comparative anatomy course was the students' increased familiarity with anatomical terminology that clearly helped the students to be more comfortable than the more traditionally taught comparative vertebrate anatomy material. The projects also fostered an understanding of why fields like comparative vertebrate anatomy need to have such a complex terminology. The students needed precise terms to convey their results to each other as their projects progressed. Interestingly, for some students studying musculature, their learning was clearly extended beyond the classroom and into their daily lives when they went to the grocery store to purchase additional specimens for their study.

Project Concerns

One significant concern about instituting an independent project component to the comparative vertebrate anatomy laboratory was that it reduced the amount of specific content that can be covered. Like Chang (2000) we had to reduce the laboratory coverage to incorporate inquiry activity into the course, and we chose to decrease the time spent on overall musculature, focusing more on the anterior musculature. We did not consider this reduction to be a serious loss because of the benefits cited above.

Another significant concern is the workload involved in an independent project. Independent projects require a significant time investment on the part of students and the instructor. This does not differ from independent projects instituted in other areas of biology. However, the types of observations necessary in an anatomical study usually require more time than typically is available in one or two laboratory periods set aside for the project. An anatomical project is not like an experiment that can be planned to start and stop at very specific times. It was occasionally difficult to effectively convey to the students the need to start early and that anatomical data require checking and re-checking. When including a project like this, the course needs to be adjusted so that too many demands are not placed on the students at the same time. A comparative vertebrate anatomy independent-project also requires some additional planning. Students need safe access to laboratories and specimens, often outside of class time.

Instructors need to purchase specimens of additional species for student examination. The traditionally studied dogfish sharks (*Squalus acanthias*), mudpuppies (*Necturus nebulosus*), and cats (*Felis catus*) are useful in the independent projects but they are not sufficient for most students' projects. Instructors should buy one or two individuals of a variety of species, many of which are much less expensive than cats. Some examples used include freshwater dogfish (*Amia calva*), perch, turtles,

American chameleons (*Anolis* sp.), snakes, pigeons, chickens, rats, rabbits, and minks. If the school is located in a rural area, students can be encouraged to bring in road kill, provided that the instructor has obtained and distributed copies of the proper permits and there is refrigeration for the specimens. Fetal pigs are not as highly recommended because of their earlier stage of development which means that they are less directly comparable to adult specimens. Students initially complained that they had no "talent" in making sketches of their observations. Digital technology such as a digital camera and microscope attachment can be employed. This allowed the students to document their work and alleviated some of the worries that the students had concerning illustrations. However, it is always valuable to have students sketch some part of the structure. Sketching forces close observation and encourages kinesthetic learning.

ASSESSMENT

Evaluation of the independent research project was informal involving written course evaluations and individual student interviews. Generally, students considered the independent project to have been a valuable experience that contributed to their knowledge and appreciation of the discipline of vertebrate anatomy. The most frequently cited student concerns were centered on the amount of work required to complete the independent project while still being held responsible for learning much of the "typical" comparative vertebrate anatomy laboratory content. Students usually suggested a reduction of the "typical" material as opposed to elimination of the independent project. The instructors clearly noted an increase in student enthusiasm and a reduction in complaints about the complex terminology of anatomy. This was particularly noticeable in students who were doing poorly in either the lecture, or on lab exams that required memorization of structures. The instructors were also satisfied that students were able to recognize vertebrate anatomy as a field, like other fields in biology, which is based on testing assumptions using empirical evidence.

CONCLUSIONS

An independent research project component implemented in undergraduate Comparative Vertebrate Anatomy laboratory courses at Emory and Henry College and Regis University was successful at actively engaging students in the field of comparative vertebrate anatomy as a science. Although implementing such a project does require time, consideration, and organization on the part of the faculty member and the students the benefits of such a project are tangible. The project engaged students as scientists, honing their interpretive skills as well as their technical anatomical skills. In addition, the

project placed the entire comparative vertebrate anatomy course within the larger context of science at a time when courses in anatomy are looked at by students and sometimes administrators and other faculty as less “scientific” than more classically experimental disciplines. We hope that others will implement similar research-based projects in comparative vertebrate anatomy courses to ensure that anatomical disciplines do not get “left behind” as

science education increases in its emphasis on active learning, cooperative learning, and problem solving (National Science Foundation, 1996; National Research Council, 2000).

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Making Quantitative Genetics Relevant: Effectiveness of a Laboratory Investigation that Links Scientific Research, Commercial Applications, and Legal Issues

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ABSTRACT: As students apply their knowledge of scientific concepts and of science as a method of inquiry, learning becomes relevant. This laboratory exercise is designed to foster students' understanding of the genetics of quantitative traits and of the nature of science as a method of inquiry by engaging them in a real-world business scenario. During the investigation, students explore the question of whether the patent rights of a commercial producer of sunflower seeds have been infringed upon by a rival company. Students work as a research team to explore the question, making observations, collecting and analyzing data utilizing statistical tools, and ultimately drawing conclusions regarding possible patent violations. Student-evaluations of the exercise indicate that they perceive that the activity fostered their understanding of genetic principles and of important aspects of scientific inquiry and made the content relevant by linking it to real-world issues.

KEYWORDS: genetics, relevant content, statistics, t-test, patent rights, quantitative traits

INTRODUCTION

The use of real-world, student-relevant activities, assignments and curricula that invoke students' critical thinking skills is recognized as a powerful approach to engage students and promote meaningful learning (Biack and Biack, 1999; Chin and Brown, 2000; Crow, 1989; van Rooyen & de Beer, 1994). Such activities allow students to apply their understanding of scientific principles and science as a method of inquiry. These applications are vital because they foster the formation of informed decisions, and make learning meaningful (Chang, 2000; Sojka, 1992; Demers, 2003). The connections between scientific research and commercial ventures that have associated legal issues provide a rich area from which to develop activities that are relevant to students' lives and promote critical thinking.

An objective of the genetics course at Middle Tennessee State University is to foster student

understanding of genetic principles and scientific methods while encouraging students to critically apply their knowledge to answer relevant personal and societal questions. This paper describes a laboratory investigation that utilizes a real-world business scenario involving potential patent right infringements with respect to sunflower seeds. The laboratory is designed to:

- promote student understanding of quantitative traits.
- foster student understanding of science as a method of inquiry, including the analysis of data using statistical procedures.
- introduce students to the connections between scientific research and commercial applications, including legal issues associated with the patenting of organisms.

- provide course content that is interesting and relevant to students' everyday lives.

As students investigate questions concerning potential patent right infringements, they utilize the tools and techniques commonly used in scientific decision-making -- characteristics recognized as fundamental to quality science education (American Association for the Advancement of Science, 1993; National Research Council, 1996; National Science Foundation, 1996).

BACKGROUND (PRE-LAB DISCUSSION)

The laboratory exercise is prefaced with a discussion reminding students of the historic events leading to the contemporary understanding of heredity—including the 'Mendelian viewpoint,' which held that all evolutionarily important genetic differences are qualitative and discontinuous, and the 'biometrical viewpoint,' which held that genetic variation is fundamentally quantitative and continuous. The multiple gene hypothesis (polygenic model) of inheritance contributed by H. Nilsson-Ehle, which shows that continuous variation can be explained in Mendelian terms, is also discussed. It is explained that traits that are controlled by polygenes show a continuous variety of phenotypes (as opposed to a few discrete phenotypes), and vary by degree. Hence, their phenotypes can be expressed as a number rather than a descriptive word (e.g. tall or dwarf). It is pointed out that this fact makes it possible to apply statistical methods for comparing two populations with respect to quantitative traits, such as the number of stripes per achene on sunflowers, to determine if differences exist. Additionally, it is noted that in the world of commerce, genetic matters are sometimes intertwined with legal issues, and a trait seemingly as meaningless as the number of stripes on sunflower seeds can be of particular significance.

In addition to the necessary genetic background, students are made aware of the growing commercialization of genetic discoveries. The landmark U.S. Plant Patent Act of 1930 and the 1980 U.S. Supreme Court decision in the case of the Commissioner of Patents and Trademarks v. Chakrabarty are cited as indications of the growing importance of patented varieties of plants, microorganisms, and other life forms. The former cleared the way for commercialization of plant varieties based on application of classical genetic knowledge; whereas, the latter cleared the way for protection of novel genetic varieties of microorganisms created through recombinant DNA technology (<http://www.fcgp.org>; accessed 9/16/2004). Awareness of the growing importance of proprietary issues in genetics is further emphasized through a simple Web assignment in which students are asked to find current

examples of cases involving possible patent right infringement.

DESCRIBING PHENOTYPIC VARIATION

Students are supplied with a data set of ear length in corn (a quantitative trait). The calculations of the mean and standard deviation are reviewed. The phenotypic variation exhibited in the data set is utilized to illustrate the normal distribution and the relationship between sample means and standard deviations. Students are given a small data set to practice calculating variance and standard deviation.

Comparing Two Populations (Student's t-test)

The concept of standard error and its computation are reviewed. It is pointed out that much of the work in science involves the use of samples or subsets of populations and that standard error, the standard deviation of a distribution of sample means, is incredibly useful in scientific research as a means of determining whether populations differ with respect to a parameter of interest (e.g. stripes/achene in sunflowers). Students are asked how likely it is that two successive sample means from a population will be the same. They typically appreciate that it is highly likely that the two means will be different despite the fact that they are drawn from the same population. Students are then asked, "How can we be certain that two means are different enough for us to be suitably confident that they came from different populations?" Student response is utilized to expand the discussion of how statistics are useful to scientists, and that statistical analyses indicate how much difference must exist between two means for them to be deemed 'significantly different' at a given significance level (α -level). Students are reminded that in science the minimum significance level is 0.05 -- that is, differences that are realized with a 5% or less chance of error are deemed 'statistically significant.'

Students are asked to name types of statistical tests with which they are familiar. Chi-square is often listed by students and is used along with others that are mentioned to expand the discussion of different types of statistical tests. If students don't mention 't-tests' it is offered as a statistical test that is particularly useful in determining if differences between two sample means are meaningful. Students are then presented with the formula for calculating the independent samples t-test and the assumptions associated with its use are reviewed. Students are asked, "How can the calculated t statistic be used and what does it mean?" Student responses are utilized to point out that the t-test compares the actual difference between two means in relation to the variation in the data. It is observed that the two-sample t-test can be used to study quantitative traits in genetics to determine if two samples are drawn from the same phenotypic (and genetic) population.

Students are asked if they are aware of business applications in which determining if organisms represent a single or two different populations would be important. Student responses are used to expand the discussion to include legal issues surrounding the patenting of organisms and patent right infringement. Discussion of the significant research and development costs to companies in the production of seeds of proper genetic stock, and the desire to protect their discoveries through the patent rights, sets the stage for the laboratory exercise.

THE EXERCISE

The Sunflower Seed Scenario

Students are asked to consider the following scenario:

Company A has developed and obtained patent rights for a variety of sunflower (variety VTX1) that is characterized by possessing a specified number of stripes per achene. The company believes that a competing company (Company B) has infringed on their patent rights by marketing the same variety of sunflower under a different name (variety B100).

Students, working in research teams of two individuals, are charged with using their understanding of quantitative traits and statistical procedures to determine if there is a patent right infringement. Research teams are instructed to:

- obtain 15 seeds from each company's stock.
- count the number of white stripes that run at least half the length of each achene (ignore differences in stripe width -- a stripe is a stripe).
- count all the way around the achene. If a stripe wraps around the edge, make sure you only count it once.
- exclude seeds that are immature and lack stripes or have been mechanically damaged by the harvesting process.

As students complete the exercise, they are asked to calculate the mean and standard error for each sample. As an assignment for the next lab meeting, students are asked to utilize the data they collected to form a statistical analysis (t-test) to determine if the data support the null hypothesis, the two samples are from the same population and Company B has infringed on the patent rights of Company A, or the alternative hypothesis that the seeds represent two genetically distinct populations. Additionally, students are given data from seeds of a third company, Company C. Company C is marketing a variety of seeds (variety MSR2) suspected of representing an infringement of Company A's patent rights. Students are asked to analyze these data in a similar fashion to determine if Company C may have infringed on the patent rights of Company A. The data supplied for Company C's seeds are: 4, 7, 6, 8, 3, 4, 5, 6, 3, 3, 5, 8, 3, 4, 5.

RESULTS

At the beginning of the next lab meeting, student research teams present their observed data, statistical analyses and conclusions with respect to potential patent right infringements. Most research teams find no statistically significant difference between the two observed samples and conclude that the data provide initial support that Company B may have infringed on the patent rights of Company A, and that seed varieties VXT1 and B100 are genetically the same with respect to the number of stripes/achene (Table 1). Further, when students analyze the data from Company C's variety, they typically do find a statistical difference between the varieties and conclude that the varieties represent two different populations, indicating that Company C likely has not infringed on the patent rights of Company A (Table 2).

Table 1. Two sample t-test for number of stripes per achene in sunflower varieties.

Statistic	Variety of Sunflower	
	VXT1	B100
n	15	15
\bar{x}	8.46	8.4
s	3.86	2.98
SE	0.99	0.79
s_d	1.27	
t	0.047	

Table 2. Two sample t-test for number of stripes per achene in sunflower varieties.

Statistic	Variety of Sunflower	
	VXT1	MSR2
<i>n</i>	15	15
\bar{x}	8.46	4.93
<i>s</i>	3.86	1.69
<i>SE</i>	0.99	0.44
<i>s_d</i>	1.08	
<i>t</i>	3.29	

The results of research team presentations are used to expand the discussion to include issues of sample size and the power of statistical tests. Additional data from Company C's variety are provided (30 more seeds) and the data of Company A's seeds from three research teams are combined. A t-test is calculated using the increased sample size to demonstrate that differences can be declared at lower significance levels when samples are larger. The discussion may be expanded further to include the range of calculated power of a given t-test and the sample size required to achieve a stated level of power.

INSTRUCTOR NOTES

Before students obtain their samples, the seeds are inspected and chaff/debris, as well as badly abraded and immature seeds, are removed. Sunflower seeds from a common source are acquired from a local seed store and divided into the two varieties -- VXT1 and B100. Thus, students typically find that the two populations being compared are not different, leading them to conclude that Company B may have actually violated the patent rights of Company A. The supplied data for Company C are discernibly different from that of Company A, leading students to conclude that there is no patent right infringement in this case. As mentioned above, this exercise is often combined with an assignment in which students search the Internet for contemporary cases of patent right infringement, or possible infringement. This assignment helps to foster student interest. When combined with prior background pertaining to the nature of quantitative inheritance and at least some familiarity with the concept of statistical inference, students are prepared to successfully complete the exercise. Potential users of this exercise, or a similar exercise, should note that the exercise can be adapted to fit the background of a particular student population (typically, our students are junior level biology majors). The exercise may, for example, be successfully completed without consideration of the effect of increased sample size on

the conclusions reached or mention of the concept of 'power.'

STUDENT EVALUATION

The rationale for developing this exercise was to involve students in an investigation that allowed them to apply their understanding of genetic principles and of science as a method of inquiry in a real-world context in such a way to make the content relevant and to invoke their critical thinking skills. The educational objectives of the assignment center on increasing students' understanding of quantitative traits and of science as a method of inquiry, as well as fostering their appreciation of the connections between science and industry. Additional objectives include making the content relevant and interesting to students while engaging their critical thinking skills. To assess student perceptions of the effectiveness of the exercise, students in four lab sections were administered a seven-item survey after they turned in their assignment (Table 3). The survey, which was filled out anonymously, asked students to rate each aspect of the exercise on a numerical scale according to the degree with which they agree or disagree with each statement.

Mean scores for all items were above 3.7 on the five-point scale (Table 3). The majority of students indicated a degree of agreement for each item. Overall, the scores suggest that students perceived that the activity achieved its educational objectives and fostered their understanding of genetic principles and of important aspects of scientific inquiry while making the content relevant and meaningful by linking it to the real-world issue of patent right infringement. It is interesting that the mean scores were somewhat lower and the amount of deviation was greatest for the two questions: 1) Have a greater understanding of legal issues associated with the patenting of organisms, and 2) The laboratory activity was interesting to me. This might suggest a difference in the background of the students and thus their appreciation for these areas, or that changes in the presentation of the materials should be made to greater emphasize these areas.

Table 3. Students' evaluation of effectiveness of the laboratory exercise.

QUESTION: As a result of the laboratory exercise I believe that I now:	Score	SD
have a greater understanding of quantitative traits. Disagree 1 2 3 4 5 Agree	3.84	0.82
have a greater understanding of the role of statistics in science. Disagree 1 2 3 4 5 Agree	4.22	0.84
have a greater appreciation of the connections between science and industry. Disagree 1 2 3 4 5 Agree	3.74	0.99
have a greater understanding of legal issues associated with the patenting of organisms. Disagree 1 2 3 4 5 Agree	3.80	1.10
am more comfortable interpreting the data (statistical analysis) in scientific reports. Disagree 1 2 3 4 5 Agree	3.89	0.95
QUESTION: The laboratory activity:		
was interesting to me. Disagree 1 2 3 4 5 Agree	3.80	1.14
made the content (quantitative traits) relevant. Disagree 1 2 3 4 5 Agree	4.16	0.78

Note: n = 76

CONCLUSIONS

As students apply their understanding of scientific principles and science as a method of inquiry to real-world situations, their learning becomes connected to their experiences and is thus more meaningful. Often students lack an appreciation for the connections between science and the broader realms of business, society, and philosophy. This laboratory investigation is designed to foster student understanding of genetic principles and of science as a method of inquiry by engaging them in a business application involving potential patent right infringements. It gives them a real-world context for the biological and scientific

content. As students conduct the exercise they work as part of a research team, make observations, collect and analyze data utilizing statistical tools, and draw conclusions. Initial feedback suggests that students perceive that the laboratory exercise provides them with an increased understanding of the genetics of quantitative traits and science as a method of inquiry while making the content relevant and interesting. Further, the activity serves as a concrete referent of science as a method of inquiry and of the connections between science and business upon which the course can be further developed.

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Does Eating Breakfast Affect the Performance of College Students on Biology Exams?

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Abstract. This study examined the breakfast eating habits of 1,259 college students over an eleven year period to determine if eating breakfast had an impact upon their grade on a General Biology exam. The study determined that there was a significant difference in the performance on the exam with a higher percent of the participants, who had eaten breakfast passing the exam. The study found that only 65.6 percent of the students participating in the study had eaten breakfast. This finding supports the results of several other studies that people of college age show an increase in the percent skipping breakfast over individual of a younger age.

Keywords: general biology, exam performance, standardized tests, breakfast

INTRODUCTION

Many studies have examined the link between eating breakfast and performance in school (Gagnard, 1986; Mathews, 1996; Pollitt, Leibel, & Greenfield, 1981; Pollitt, Lewis, Garza, & Shulman, 1982; Simeon & Grantham-McGregor, 1989; Worobey & Worobey 1999). These studies have consistently pointed toward the importance of eating breakfast and doing well in school. Several researchers (Cantore, 1999; Given, 1998; Kleinman, 1998; and Pollitt, 1995) further suggest that breakfast can have a significant impact upon the grade obtained in a standardized test. Staub (2000) pointed out that this type of research has played an important role in providing evidence that supports the need for school lunch and breakfast programs. Morse and Pollack (1988) recognized that the importance of eating a good breakfast does not end after adolescence, but is an essential part of a healthy life style.

However, much of the research has been focused on public school students, ranging from pre-K up to high school. Fewer studies have focused on college students and the effect breakfast may have had on their performance. Some of the studies that have examined this segment of the population have measured glucose levels and performance of college students on memory

tests or minimal skills tests (Gagnard, 1986; Deije, Heemstra, & Orlebeke, 1989; Benton & Parker, 1998; and Benton & Sargent, 1992). Their research has consistently agreed with earlier research that breakfast does play a crucial role in performance. This longitudinal study intends to add to the body of knowledge on the relationship between academic performance and eating habits by examining the performance of college students who ate breakfast on the day of major Biology exams.

PROBLEM STATEMENT

The fundamental question that drove this study was to determine if there were a significant difference in the performance on Biology exams of college students who had eaten breakfast and those who had not eaten breakfast.

SAMPLE

The study involved 1,259 community college students who were enrolled in General Biology I classes. The classes involved in the study began at 8, 9, or 10 am. The study extended from spring 1993 through fall 2004.

The study was conducted on the Brenham campus of Blinn College, a residential community college in Brenham, Texas. The students at Blinn College are

predominantly freshmen, 80.4 percent. Males comprise 50.2 percent of the Brenham campus population and females comprise the remaining 49.8 percent (Blinn College, 2003). Most of the students on the Brenham campus are traditional students who are between 18-21 years of age, with an average age of 20.6 (Blinn College, 2003). The majority of students, 87.1 percent, on the Brenham campus are full time students, taking at least 12 credit hours. The ethnic breakdown of the Brenham campus students are as follows: Caucasian 74.8 percent, African-American 16.3 percent, Hispanic 7.8 percent, Asian 0.5 percent, American Indian 0.2 percent, and foreign students comprise 0.4 percent of the population (Blinn College, 2003). While the study did not track ethnicity or gender, the General Biology classes are freshman level courses with no prerequisites and, as such, contained comparable demographics to the campus as a whole.

METHODOLOGY

The second major exam was selected for determining the effect of breakfast on test results. I chose to use the second major exam as a focal point for the study in an attempt to minimize the effects of students adjusting to a new class and professor. A single survey question was placed at the top of the exam that asked, "Did you or did you not eat breakfast

this morning?" Following the premise of the American Dietetic Association (1996) that breakfast is when you eat, not what you eat, the administrator of the exam explained that breakfast could be a Pop Tart, a bowl of cereal, piece of cold pizza, piece of fruit, or a full blown traditional breakfast. It was further explained that a cup of coffee alone was not considered breakfast. The students were then asked to indicate if they had breakfast or not by checking the appropriate box. A limiting factor in this study is that the students were not asked for details concerning what they ate for breakfast or when they had last eaten. Another limiting factor to this study was that it was only conducted in General Biology classes at a single community college.

FINDINGS

The data revealed that 65.5 percent self identified they had eaten some type of breakfast. Of those that had eaten breakfast, 72.7 received a "C" or better on the test. The data showing the number of students who had eaten breakfast and those that had not eaten breakfast along with the corresponding letter grade they received on the exam are shown as a bar graph in Figure 1. The data show the actual number of students out of 825 who ate breakfast and out of the 434 who did not eat breakfast.

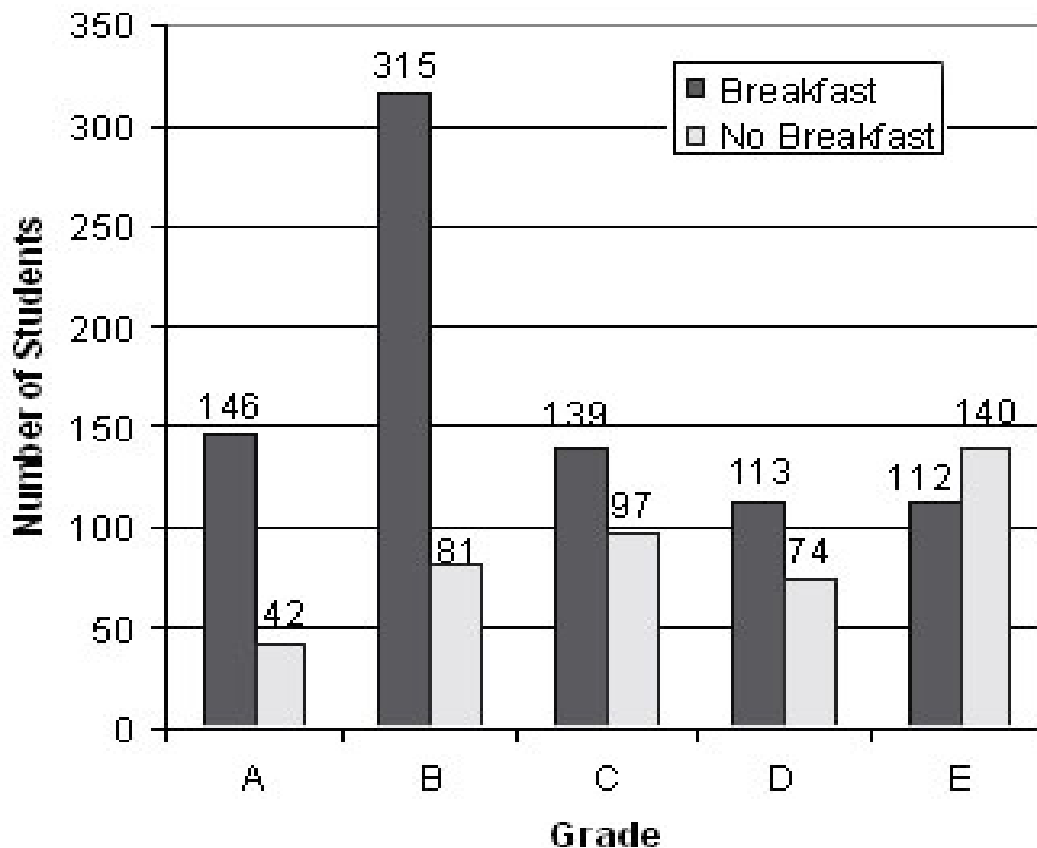


Figure 1. Raw Data Showing Student Performance and Breakfast Consumption

As one examines the letter grade categories, the data clearly show significant difference in the performance of those who had eaten breakfast and those that did not have breakfast. During the course of the study 188 students made an “A” on the second exam, this includes 17.7% of the students who had eaten breakfast and 9.7% of those who had not eaten breakfast. Similarly, the results show that 38.2% of the students eating breakfast received a “B”; whereas, only 18.7% of the students not eating breakfast received a “B”. At the “C” grade level, we see a reversal of the

trend as only 16.9% of the ones eating breakfast and 22.4% of those not eating breakfast receive a “C”. In the case of a “D” grade, the percents are 13.7 for students who had eaten breakfast and 17.1 for those who had not. A large difference occurs at the “F” level with only 13.6 percent in the case of the students having eaten breakfast, but 32.3 percent for those who hadn’t receiving an “F”. Figure 2 graphically illustrates the data presenting an obvious disparity in performance between those students who ate breakfast and those that did not.

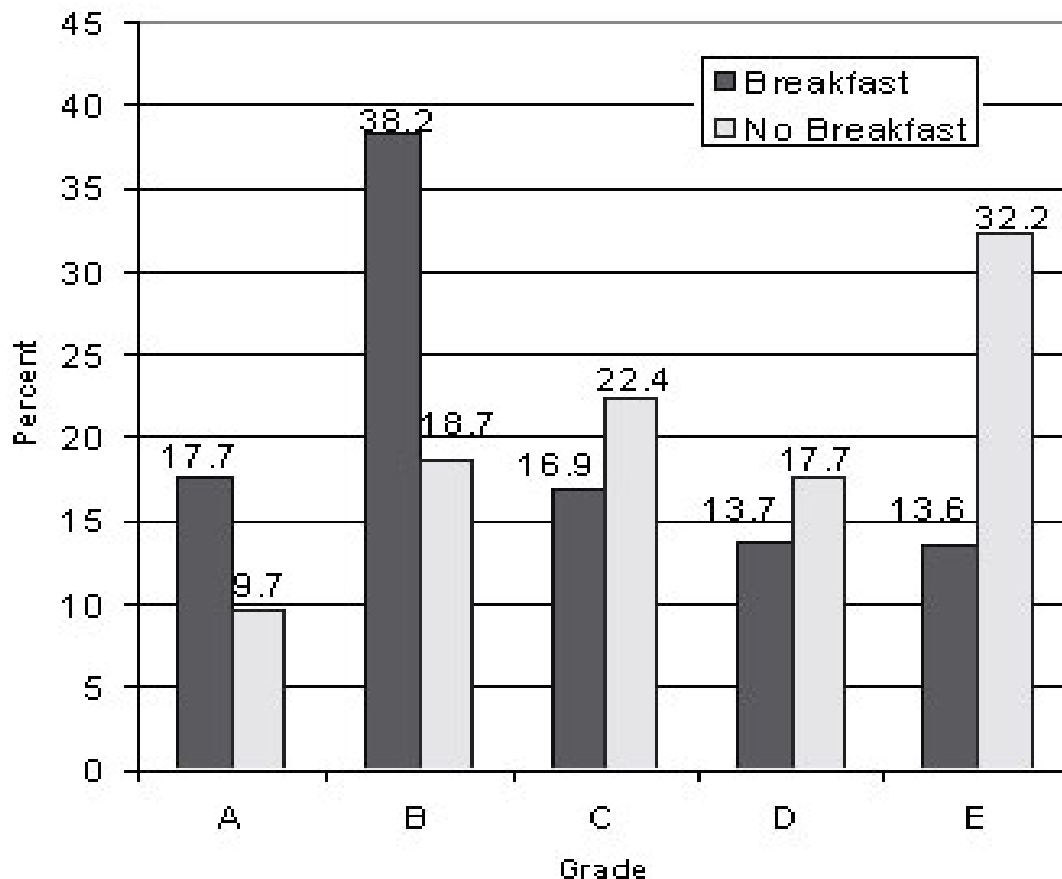


Figure 2. Percent Performance of Those Student who had Eaten Breakfast and Those that did not have Breakfast

RESULTS AND DISCUSSION

This study showed that students who ate breakfast had a higher success rate on General Biology exams than those students who did not eat breakfast. This finding supports earlier research, which indicated that eating breakfast affects student performance. It also provides a platform from which to strongly encourage college students to eat breakfast as a method of augmenting their study strategies and maintaining a healthy positive life style.

It is equally important to point out that 72.7 percent of the participants who passed the test (C or better) had eaten breakfast. In contrast, 50.8 percent of

the students who had not eaten breakfast passed the test (C or better). While eating breakfast does not insure that students will pass the exam or replaces the need to study, this research does suggest that eating breakfast provides students with an advantage on major Biology exams.

Another finding in this study is the overall percent of students, 65.6, who self identified as having had breakfast. According to the United States Department of Agriculture (1998) and a study conducted by Haines, Guilkey, and Popkin (1996) the percentage of people who eat breakfast decreases with age. The USDA study claimed that 92 percent of

children ages 6-11 eat breakfast, while only 75-78 percent of adolescents ages 12-19 are reported as eating breakfast. According to a report in the American Heart Association Journal (Kartashov, et al., 2003) only 47 percent of Caucasians and 22 percent of African Americans reported daily breakfast consumption. In another recent survey conducted by Harris Interactive (2003) consisting of 3,925 American adults, only 38 percent eat breakfast every day. These studies indicate a general trend that adults skip breakfast more frequently as they age. The average age for the participants in this study is 20.6 (Blinn College, 2003). The data from this study correlate with the pattern of decline in eating breakfast as determined by the prior research (Figure 3).

It must be recognized that this preliminary study constitutes a correlation between breakfast and exam scores, not a regression. Other factors such as when

the student arose, when he/she went to bed, the amount of time spent studying for the exam, etc. must be considered to help determine if the results are a correlation rather than a cause and effect.

CONCLUSION

Although this study was only conducted in General Biology classes at Blinn, it may suggest a trend at colleges in general. Research mentioned earlier in this paper and similar unreferenced studies have provided ample evidence that school children's mood and performance levels are affected by eating breakfast. Still other research has investigated the levels of blood glucose in affecting performance of college students. The results from this study support the general conclusion that eating breakfast has an effect on test results.

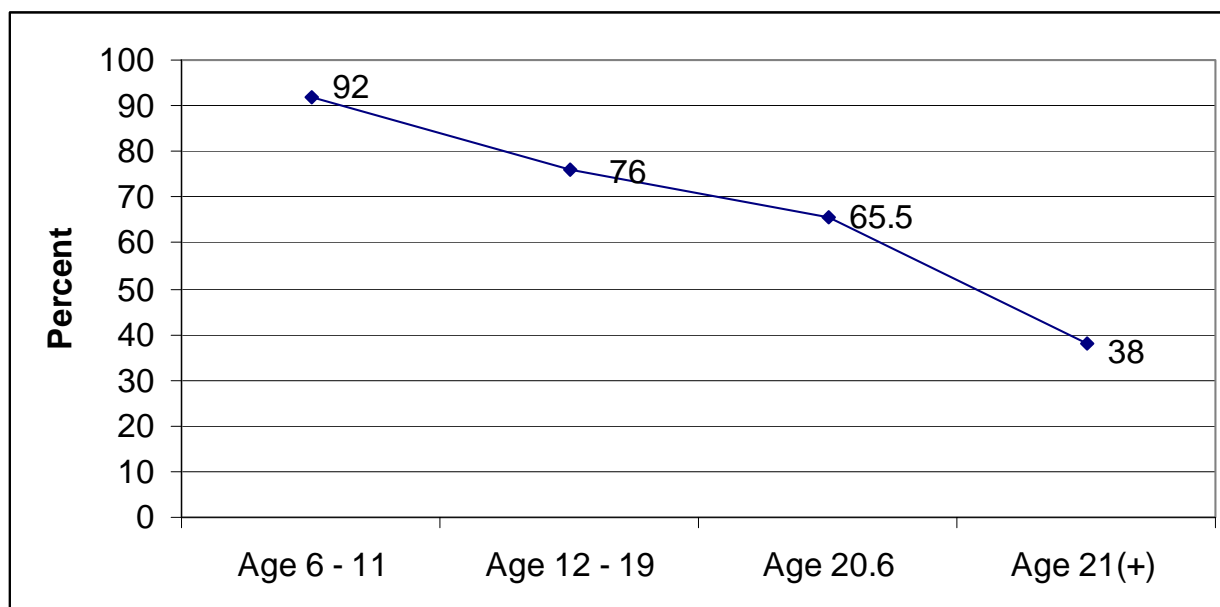


Figure 3. Decline in Breakfast Consumption with Age

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John Carlock Award 2004 Awardees' Impressions

I went to the 2004 ACUBE conference looking to better my teaching skills. I came away with a lot more. I found that lecturing is not always the best way to teach a subject. Hands-on learning and group activities may be better ways to teach material depending on the type of audience you have, non-major or major.

It was hard to decide which sessions to attend. The two motives that steered me were if the session would help me as a student or as a teacher. The topics that I enjoyed the most were the ones that integrated the internet and other technologies into the classroom. I really enjoyed Mark Bergland and Karen Klyczek's presentation on the web program Case It. I thought that it was really cool because you could should how a gel was set up and get results without waiting forever for the gel to run. This could be taken into a non-majors class to give a little taste of the work behind the science. I did not realize that programs like BioQUEST, LabWrite, and Case It were out there. I think I am preaching to the choir when I say that these new ways of teaching will increase the student's understanding of biology. Today just about every student has a cell phone, most classes have a web page, and most scientific equipment has computers integrated into them. What I am getting at is that introducing more computer-based learning and application into the classroom (non-major or major) may entice the students enough to think about a possible degree change or at the least give them the curiosity to learn more.

The presentations that I attended were very informative as a teacher and in the end as a student as well. The LabWrite program is a great tool to use when writing those dreaded lab reports. They showed me new technological ways to teach and learn biology. I am a graduate student and the class that I teach has a structure that is pretty much set. But in the future I could use LabWrite in my classroom to help me teach the structure of a lab report.

I hope that teaching is in my future. If so, I will use what I have seen at this year's ACUBE conference in my own classroom. This experience has provided me with a connection to the bigger world of biology and the people in it. Thank you very much for allowing me to attend and for giving me the John Carlock Award.

Terra Wineman

The October 2004 ACUBE meeting was the first I have attended. I am a first year graduate student at Southeast Missouri State University. I teach three sections of Anatomy and Physiology Lab I, with a total of 55 students who are nursing, physical therapy, and sports medicine majors.

I had never thought that there was such an organization as ACUBE. I have wondered why there was not a teaching component to university professors' training. I didn't think many worried about it too much. Well, this conference showed me differently. It was great to meet a community of college and university researchers who are devoted to teaching and genuinely concerned about student learning. I worry about the classes I teach, and hope I am communicating effectively. I take a seminar course on teaching with the rest of the graduate assistants, which helps some. However, getting to listen to a weekend of presentations on how the professionals do it was of great help. The seminars on "Technology in the Classroom" will be useful to me in my own classes in which I am a student, in particular the workshops on information databases and how to use them.

Case-based learning is something I had heard of before, but I wasn't very clear on. Several seminars talked about using this to talk about different aspects of A & P -- incorporating cellular structure, organ systems, physiology, pathology, and such into a broader discussion centered around one case: a problem someone has, or a question about how something works. I can see how this would be a good way for students to learn and incorporate the information into real life. I have been resistant to non-traditional teaching. I prefer a good solid lecture and lab, separated. I thought non-traditional teaching made the class move slower, was too wishy-washy/touchy-feely, prevented in-depth coverage of material, and lowered the bar. I think these are typical protests. However, I saw concrete examples of how case-based learning and student-driven discussion have worked in classrooms. I found the ideas interesting. I think the key is to have definite structure and boundaries, with definite choices for students to help determine course content or the order of coverage, etc. My experience as a student has given me definite prejudices against lack of structure or constant change of the syllabus. Students need to know what to expect. I think this is why I was so resistant to what I thought student-driven learning was. I have changed my mind about this. I teach lab with students in groups, and I have a very good instructor who gives me lesson plans and ideas about how to teach the class. I have been resistant to some of these ideas, but having them confirmed at ACUBE and demonstrated by other professors in workshops has made me a more willing practitioner of these techniques.

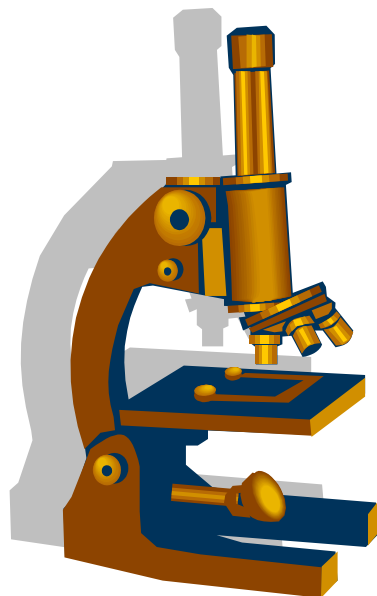
Wabash College was a beautiful setting for the conference, with great facilities. The plethora of internet jacks was a definite plus. The food was great. Dr. Brett was very nice and gave me a crinoid fossil which is now sitting next to my treasured singing-nun-finger-puppet and my rocks from various campsites. The fossil will remind me of ACUBE. All in all, this conference was great, and I hope to attend in the future. (It is at Southeast Missouri State University next year, everybody. Hope to see you!)

Jennifer Layton

Association of College and University Biology Educators 49th Annual Meeting

Southeast Missouri State University
Thursday October 13, 2005-Saturday October 15, 2005

Call for Presentations Conference Theme: Interdisciplinary Exploration



Interdisciplinary can mean a lot of things. One sort of interdisciplinary exploration was the Lewis & Clark expedition in which many disciplines were used to complete a major project. In addition to scientific sampling, they created maps, described the geological features of the land and waterways, wrote, created images, lived in other cultures, did some politicking and diplomacy, evaded enemies, hunted, built lodging, and used orienteering and survival skills.

Another sort of interdisciplinary exploration is the way in which many biological problems are formulated and studied. For example, modern genomics, which uses statistics, engineering, molecular biology and computer science is an interdisciplinary approach to investigating problems as diverse as systematics and nutrition.

We invite you to submit a paper, poster or workshop on ways you incorporate interdisciplinary exploration or approaches in your biology teaching. Do you team-teach a class with someone from another discipline? Do you give students assignments that are overtly interdisciplinary? Have you designed a course centered on a project or theme that is interdisciplinary (e.g., land use for a particular plot of land, or field courses set in a different environment)? Are your nonmajors science classes becoming a combination of chemistry, physics, biology and earth science? Do your courses contain ethics, economics or global studies?



To submit a proposal for this meeting submit the following form by July 15, 2005 and email it as an attachment to Jill Kruper, Program Chairperson, ACUBE 49th meeting.

Email: jill.kruper@murraystate.edu

Note: At least one presenter for each poster, paper or workshop must be an ACUBE member. (Annual dues are \$30.)



The 49th annual meeting of **ACUBE** will be held at Southeast Missouri State University in Cape Girardeau, MO. Join us for “Interdisciplinary Exploration.”



Cape Girardeau is a bustling city of 37,000 people nestled on the banks of the Mississippi. Beginning as a trading post in the late 1700's, Cape Girardeau was an early stop on the Lewis and Clark expedition, was the site of a battle in the Civil War, and today retains much of its character and charm in the riverfront business district, a Missouri Main Street community known as “Old Town Cape.” As a regional center (and the largest city between St. Louis and Memphis), Cape Girardeau offers excellent restaurants, shopping, and a wealth of antiquing possibilities. Known for its medical, educational and retail resources, over 90,000 people come to work daily in Cape.



Southeast Missouri State University sits on a hill above the Mississippi about 1 mile from Old Town Cape. Originally a teacher's college, Southeast today is a comprehensive regional university offering bachelor's and master's degrees to its 8500 students. Our meetings will be held in the University Center meeting rooms, with some sessions in the adjacent Kent Library. All meeting rooms are handicapped accessible. The campus is on rolling terrain, nice for a lunch time walk. See images at www.semo.edu

Nearby state parks in Missouri and Illinois include the Trail of Tears with its rugged terrain for hiking and Big Oak Tree State Park near New Madrid MO with its remnant swamp ecology in MO. Giant City State Park and Little Grand Canyon (Fern Cliff) are state parks in Illinois with interesting geological formations and plants. Horseshoe Lake recreation area near Olive Branch IL offers fishing and birding.

The Cape Girardeau Convention and Visitors Bureau website provides much information on activities and attractions in the Cape Girardeau region. Go to <http://www.capegirardeaucvb.org/>

Cape Girardeau's weather in October is likely to be warm, but visitors are advised to check the forecast before traveling (it has snowed in October recently). Dress for most all activities in Cape is casual and comfortable.

For more information on proposing a presentation or registering for this meeting, or for housing info and driving directions go to <http://acube.org/> and click on the meetings button.

ACUBE 48th Annual Meeting

Wabash College
Crawfordsville, IN

1st Steering Committee Meeting October 14, 2004

Place: Hays Hall, Room 002

Present: Pres Martin, Ethel Stanley, Margaret Waterman, Tim Mulkey, Conrad Toepfer, Jill Kruper, Lynn Gillie, Austin Brooks, Joyce Cadwallader, Brenda Moore, Janet Cooper, Bill Brett, Terry Derting

Absent: Ed Kos, Neil Grant, Abour Cherif

Time: 3:00- 5:00 pm, 9:00-10:00 pm

Call to Order

Approval of Agenda

M/S/A with corrections

Approval of Minutes –

M/S/A with corrections

Reports of Standing Committees

Executive Secretary – Pres Martin

Assets are increasing for the society. Total assets as of October 11, 2004 are \$16,516. Total income for the past year was \$10,138. Current active membership is 220 with 15 Honorary Life Memberships.

Program Chair for Present Meeting – Joyce Cadwallader, First Vice President

There are 16 paper presentations scheduled along with seven posters and workshops and three invited speakers. Concern was expressed about the recruitment of presentations for future meetings. Margaret Waterman proposed sending flyers out to prospective presenters in May. The flyers should encourage presentations from first-time participants. It was also proposed that the July deadline should be a final deadline with presentations submitted after July being presented as a poster.

Local Arrangements Chair for Present Meeting – Austin Brooks, Second Vice President

Approximately 50 participants are signed up for the meeting. It would be helpful if the registration form included when the participant would arrive at the meeting so that catering numbers could be confirmed. Three exhibitors are scheduled to present. Eli Lilly and W. H. Freeman are sponsoring specific events for the meeting.

Nominations Committee Report – Aus Brooks, Janet Cooper (reporting), Neil Grant

Four people have been contacted about serving on the steering committee (Laura Salem, Marya Czech, Wyatt Hoback, Bobby Lee) and they have agreed to be nominated for the position.

Co-editors *Bioscene* Report – Tim Mulkey, Ethel Stanley

The May and August issues are in the mail. Delays in getting the issues out are due to authors delaying completion of their corrections. We need more articles in the queue so that there will not be a delay in publication of future issues. Board members are encouraged to recruit future authors. ES reported that the cost for a copy has increased by 50 cents. It was proposed to have more copies published to bring down the cost. Extra copies could be given to new members. An 'In this World' Image contest could be used to help collect images for use in *Bioscene*. Margaret Waterman also proposed having a website as a collection point that could be used by the public to submit potential images.

Constitution Committee – Margaret Waterman (reporting), Terry Derting, Lynn Gillie

The proposed changes of the constitution are posted on the web and they will also be printed in the next issue of *Bioscene*. The membership will vote on these changes.

Awards: Honorary Life and Carlock – Bill Brett

Two students will be the recipients of the Carlock award.

Historian – Ed Kos

No report

Membership Committee – Aus Brooks (reporting), Bob Wallace, Conrad Toepfer

AB sent out 500 flyers to be disseminated. He is disappointed at the lack of response from the flyers with respect to the current meeting participation. Margaret Waterman proposed partnering within another organization for the annual meetings (Ex., AIBS, McGraw-Hill Publishers). Membership could be surveyed for their opinions of this option.

Internet Committee – Margaret Waterman (Chairperson), Tim Mulkey (*Bioscene* and Technical Manager), Bill Brett, Karen Klyzek, Nancy Sanders (Managing Editor)

The website has been updated by Margaret Waterman and Ethel Stanley and is now ADA compliant.

Resolutions Chairperson – Brenda Moore

Tabled until the 2nd committee meeting.

Old Business

Future meeting sites

A potential site for the 2006 meeting is Millikin University.
Ethel Stanley will ask Harold Wilkinson about this possibility.
A possible site for the 2007 meeting is Carroll College.
Brescia University for 2008 is a possibility.

Membership and relationships with other organizations, new member information packet (Lynn Gillie)

Tabled until the 2nd steering committee meeting.

Renewals of ACUBE registration (Pres Martin)

AIBS is the only organization that ACUBE subscribes to. This provides us access to their mailing lists.

Page charges for *Bioscene* (Bill Brett)

BB proposed that authors of articles for *Bioscene* should either pay page charges or become a member of ACUBE. The page charges would be \$20.00 per page.

Other Business

2005 Meeting (SE Missouri St. Univ.): preliminary report—Margaret Waterman (reporting), Greg Gabowski, Conrad Toepfer

Jill Kruper will be Program Chair. The theme will be “Interdisciplinary Explorations”. Preparations are underway for the logistics of the meeting.

2006 Meeting (Millikin University): program chair and theme ideas – Terry Derting

The membership will be asked for volunteers to help work on items for the 50th anniversary. Further discussion tabled until 2nd steering committee meeting.

Thanks to Retiring Members of the Steering Committee

Thank you to Janet Cooper and Aus Brooks for their hard work over the years.

Thanks to Nancy Truman for T-shirts and logo

ACUBE formally owns the official logo. Thanks to Nancy Sanders for getting the T-shirts produced.

ACUBE 48th Annual Meeting

Wabash College

First Business Meeting

October 15, 2004

Place: Detchon International Hall

Present: ACUBE membership

Time: 12:45 p.m.

I. Call to Order: Terry Derting

The meeting was called to order by President Derting

I. Announcements

- A. A call for submissions for “Out of this World Teaching Ideas” was made.
- B. Aus Brooks emphasized the need to attend the social hour early to take advantage of the beverages available
- C. Margaret Waterman gave an overview of next year’s meeting at SEMO. The theme is “Interdisciplinary Explorations”. A call for papers for the meeting was made.
- D. Terry Derting made a call to membership to ask for volunteers to work on the 2006 meeting

II. New Business

- A. Margaret Waterman summarized the proposed changes to the Constitution of ACUBE. The motion was put forth and discussion followed. Concern was expressed over steering committee members having to cover their costs for the winter meeting. Pres Martin expressed that there have been and can be exceptions to this, at the discretion of the steering committee. Harold Wilkinson offered an amendment that a steering committee member could petition to ask for support in such a situation. A motion was put forth to accept the amendment and was seconded, with discussion. The changes to the constitution were approved by a hand vote.
- B. A call for nominations was made and the following slate was put forth.

Members at large: Laura Salem, Marya Czech, Wyatt Hoback, Bobby Lee
President: Ethel Stanley and Joyce Cadwallader

Nominations were closed and seconded. The motion carried. Final balloting as mentioned above would occur at the evening meeting.

The meeting adjourned. Terry Derting introduced the keynote speaker; Dr. John Jungck. The title of his talk was “Computer Power and Human Learning: Using Technology as if Students Matter”.

Meeting adjourned at 1:15 pm

ACUBE 48th Annual Meeting Wabash College Second Business Meeting October 15, 2004

Place: Detchon International Hall

Present: ACUBE membership

Time: 6:45 p.m.

I. Call to Order: Terry Derting

The meeting was called to order by President Terry Derting.

II. New Business

A. Honorary Life Award

Neil Baird presented the Honorary Life Award to Harold Wilkinson.

B. John Carlock Award

Margaret Waterman presented the John Carlock scholarships to Jennifer Layton and Terra Wineman.

C. Nominations

Nominees for President (Ethel Stanley and Joyce Cadwallader) and Members at Large (Bobby Lee, Laura Salem, Wyatt Hoback, Marya Czech) gave brief introductions of themselves.

D. Announcements

Announcements were made about evaluation sheets to be completed. Dick Wilson gave a brief explanation of the significance of John Carlock to the society.

E. The Out-of-this-World Teaching Award

Wyatt Hoback presented the Out-of-this-World teaching award to Bob Wallace.

E. Results of voting -

Ethel Stanley will be President and Bobby Lee and Wyatt Hoback will be the new Members at Large.

The meeting moved to Hays Hall and Cary Mitchell presented the Keynote talk titled, "Artificial Closed Ecosystems for Human Habitation of Space".

The meeting adjourned at 9:00 pm.

**ACUBE 48th Annual Meeting
Wabash College
Third Business Meeting
October 16, 2004**

Place: Detchon International Hall

Present: ACUBE membership

Time: 12:30 pm

I. Call to Order: Terry Derting

The meeting was called to order by President Terry Derting.

II. Announcements

A. Resolutions - Brenda Moore

Brenda Moore read the Resolutions for the 2004 annual meeting at Wabash College. M/S/A

B. Executive Secretary Report - Pres Martin

PM summarized the finances of the society. Total assets as of October 11, 2004 are \$16,516. Total income for the past year was \$10,138.

C. Bioscene – Ethel Stanley

ES announced the new members of the Editorial Board. She also made a solicitation to membership for images for the cover of *Bioscene* and to write articles for the journal. If membership would not want a hard copy of the journal provided, the journal can also be accessed via the internet.

D. Presidential Address – Terry Derting

TD presented a talk titled, "Students as the Center of Modern Education."

E. 2005 Meeting – Lynn Gillie

Margaret Waterman announced that the 2005 meeting will be held at Southeast Missouri State University on October 13-15, 2005. The theme is "Interdisciplinary Explorations."

III. New Business

A. Dick Wilson asked that an addition to the resolutions be made that recognizes Pres Martin for his continued work for the society.

B. Aus Brooks made final announcements.

C. Motion to adjourn. Seconded and passed.

The meeting adjourned at 1:15.

**2nd Steering Committee Meeting
ACUBE 48th Annual Meeting
Wabash College
Crawfordsville, IN**

October 16, 2004

Place: Hays Hall, Room 002

Present: Bobby Lee, Wyatt Hoback, Brenda Moore, Conrad Toepfer, Tim Mulkey, Jill Kruper, Terry Derting, Lynn Gillie, Joyce Cadwallader, Margaret Waterman, Bob Wallace, Aus Brooks

Absent: Abour Cherif, Neil Grant, Ed Kos

Time: 1:30 pm

- I. **Call to Order** –
The meeting was called to order by President Lynn Gillie
- II. **Welcome to new members:** Ethel Stanley, President-Elect; Bobby Lee, Member-at-Large; Wyatt Hoback, Member-at-Large were introduced.
- III. **Approval of Agenda**
M/S/A
- IV. **Current and Continuing Business**
 - a. **Current Local arrangements report** – Aus Brooks
Aus Brooks reported that 57 attendees and five exhibitors were present for the meeting. There were four student registrants and 53 regular registrants. The society received \$1100 from exhibitor sponsors. Wabash College covered several costs for the meeting. Costs for food are estimated to be \$1800. The T-shirts have grossed over \$500 in revenues. Evaluations from the meeting revealed that participants wanted more exhibitors present and more posters with coordinated contact with the authors of the posters.
 - b. **Program Chair report** – Joyce Cadwallader
 - i. JC summarized the program and attendance at the meeting.
 - c. **Standing Committees**
Updated reports and changes for 2004-2005
 - i. **Constitution:** Terry Derting (reporting), Lynn Gillie, Ethel Stanley
 - 1. The new constitution was passed – The committee approved the removal of inactive steering committee members (Neil Grant and Abour Cherif). The board approved Laura Salem and Bob Wallace to fill the vacated positions.
 - ii. **Membership:** Bob Wallace, Aus Brooks
Bobby Lee and Wyatt Hoback agreed to chair the membership committee.
 - 1. A workshop was proposed for the Thursday evening event for the 2005 meeting to help motivate participation. It was proposed that Benjamin Cummings could partner as an exhibitor workshop. Margaret Waterman agreed to ask Benjamin Cummings about this possibility.
 - 2. Lynn Gillie also proposed an updated letter to be sent from ACUBE to new members.
 - iii. **Nominations:**
Conrad Toepfer agreed to chair the nominations committee.
 - 1. Steve Brewer and Ted Wilson were nominated for Member-at-Large for the 2005 election.
 - iv. **Internet:** Margaret Waterman (reporting)
MW provided a draft description of the duties for the ACUBE Website Editor, Managing Editor, and Technical Manager. Discussion followed and the matter was tabled until the winter meeting.
 - v. **Bioscene report** – Tim Mulkey and Ethel Stanley
No report
 - vi. **Honorary Life and Carlock awards:** Bill Brett
Tabled until the winter meeting.
 - vii. **Resolutions:** Brenda Moore
No report.
 - d. **Arrange for approval of minutes** –
The minutes for the 2004 meeting will be due to Lynn Gillie by November 15, 2004
 - e. **Future Meeting Sites**
 - i. 2005 Southeast Missouri State University, Cape Girardeau
October 13-15
 - ii. 2006 Millikin University, IL
October 12-14, tentative
 - iii. 2007 Loras College, Dubuque, IA

- iv. 2008 Hopkinsville Community College, Hopkinsville, KY
or Brescia University

f. 2006 Meeting

- i. Program Chair – Conrad Toepfer was asked to serve
- ii. Meeting Dates – October 12-14, tentative
- iii. Theme – 50th anniversary

V. Planning for 2005 Meeting: Margaret Waterman and Jill Kruper
MW and JK are working on the meeting. Further details will be confirmed at the winter meeting.

VI. New Business

- a. Arrangements for upcoming winter steering committee meeting.
The winter meeting will be January 28- 29 with a snow/ice date of February 4-5, 2005.

The meeting adjourned at 2:30 pm.

Respectfully submitted,
Jill Kruper
Secretary, ACUBE
October 24, 2004

ACUBE Governance for 2005

President – Lynn Gillie, *Elmira College*

President-Elect – Ethel Stanley, *Beloit College*

Immediate Past President – Terry Derting, *Murray State University*

Executive Secretary – Presley Martin, *Hamline University*

Secretary – Jill Kruper, *Murray State University*

First Vice President (Program Chair) – Jill Kruper, *Murray State University*

Second Vice President (Local Arrangements) – Margaret Waterman, *Southeast Missouri State University*

Board Members

Neil Grant, *William Patterson University*

Wyatt Hoback, *University of Nebraska-Kearney*

Bobby Lee, *West Kentucky Community and Technical College*

Brenda Moore, *Truman State University*

Conrad Toepfer, *Millikin University*

Robert Wallace, *Rippon College*

Standing Committees

Membership – Robert Wallace, *Rippon College*

Constitution- Margaret Waterman, *Southeast Missouri State University*

Nominations – Conrad Toepfer, *Millikin University*

Internet -- Margaret Waterman, *Southeast Missouri State University*

Bioscene – Tim Mulkey, *Indiana State University*; Ethel Stanley, *Beloit College*

Awards: Honorary Life Award and Carlock Award – William Brett, *Indiana State University*

Resolutions- Brenda Moore, *Truman State University*

Historian – Edward Kos, *Rockhurst University*

ACUBE

Association of College and University Biology Educators

NAME: _____ DATE: _____

TITLE: _____

DEPARTMENT: _____

INSTITUTION: _____

STREET ADDRESS: _____

CITY: _____ STATE: _____ ZIP CODE: _____

ADDRESS PREFERRED FOR MAILING: _____

CITY: _____ STATE: _____ ZIP CODE: _____

WORK PHONE: _____ FAX NUMBER: _____

HOME PHONE: _____ EMAIL ADDRESS: _____

MAJOR INTERESTS

- 1. Biology
- 2. Botany
- 3. Zoology
- 4. Microbiology
- 5. Pre-professional
- 6. Teacher Education
- 7. Other _____

SUB DISCIPLINES: (Mark as many as apply)

- A. Ecology
- B. Evolution
- C. Physiology
- D. Anatomy
- E. History
- F. Philosophy
- G. Systematics
- H. Molecular
- I. Developmental
- J. Cellular
- K. Genetics
- L. Ethology
- M. Neuroscience
- N. Other _____

RESOURCE AREAS (Areas of teaching and training): _____

RESEARCH AREAS: _____

How did you find out about ACUBE? _____

Have you been a member before: _____ If so, when? _____

DUES (Jan-Dec 2005) Regular Membership \$30 Student Membership \$15 Retired Membership \$5

Return to: Association of College and University Biology Educators, Attn: Pres Martin, Executive Secretary, Department of Biology, Hamline University, 1536 Hewitt Avenue, Saint Paul, MN 55104

