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Editor:

Stephen S. Daggett
Avila University

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Cover image: Photograph of a termite mound and naturalist Rajveer Singh in Keoladeo National Park, India courtesy of Charles Wyttenbach

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Bioscene: Journal of College Biology Teaching
Guidelines for Submissions

I. Submissions to *Bioscene*

Bioscene: Journal of College Biology Teaching is a refereed quarterly publication of the Association of College and University Biology Educators (ACUBE). Submissions should reflect the interests of the membership of ACUBE. Appropriate submissions include:

- Articles: Laboratory and field studies that work, course and curriculum development, innovative and workable teaching strategies that include some type of evaluation of the approaches, and approaches to teaching some of the ethical, cultural, and historical impacts of biology.
- Reviews: Web site, software, and book reviews
- Information: Technological advice, professional school advice, and funding sources
- Letters to the Editor: Letters should deal with pedagogical issues facing college and university biology educators

II. Preparation of Articles

Submissions can vary in length, but articles should be between 1500 and 4000 words in length. This includes references, but excludes figures. Authors must number all pages and lines of the document in sequence. This includes the abstract, but not figure or table legends. Concision, clarity, and originality are desirable. A complete submission will consist of the following:

A. Cover letter: All submissions should come with a cover letter indicating that the manuscript is being submitted exclusively to *Bioscene* and why it is appropriate for this journal. Authors may also offer graphics from the article as possible cover art.

B. Cover Sheet: Submissions should include a cover sheet that includes the title of the article, the number of words in the manuscript, the corresponding author's name, and all co-authors. Each author's name should be accompanied by complete postal and email addresses, as well as telephone and FAX numbers. Even with hardcopy submissions, email will be the primary method of communication with the editor of *Bioscene*.

C. Abstract: The first page of the manuscript should contain the title of the manuscript, the names of the authors and institutional addresses, a brief abstract (200 words or less) or important points in the manuscript, and keywords in that order.

D. Manuscript Text: The introduction to the manuscript begins on the second page. No subheading is needed for this section. This supply sufficient background for readers to appreciate the work without referring to previously published references dealing with the subject. Citations should be reports of credible scientific or pedagogical research.

The body follows the introduction. It is recommended that it be broken into sections with appropriate subheadings including Materials and Methods, Results, and Discussion. Some flexibility is permitted here depending upon the type of article being submitted.

Acknowledgment of any financial support or personal contributions should be made at the end of the body in an Acknowledgement section, with financial acknowledgements preceding personal acknowledgements. Disclaimers and endorsements (government, corporate, etc.) will be deleted by the editor.

A variety of writing styles can be used depending upon the type of article. Active voice is encouraged whenever possible. Past tense is recommended for descriptions of events that occurred in the past such as methods, observations, and data collection. Present tense can be used for your conclusions and accepted facts. Because *Bioscene* has readers from a variety of biological specialties, authors should avoid extremely technical language and define all specialized terms. Also, gimmicks such as capitalization, underlining, italics, or boldface are discouraged. All weights and measures should be recorded in the SI (metric) system.

In- text citations should be done in the following manner:

"...rates varied when fruit flies were reared on media of sugar, tomatoes, and grapes" (Jaenike, 1986).

or

"Ulack (1978) presents alternative conceptual schemes for observations made..."

E. References: References cited within the text should be included alphabetically by the author's last name at the end of the manuscript text with an appropriate subheading. All listed references must be cited in the text and come

from published materials in the literature or the Internet. The following examples indicate *Bioscene's* style format for articles, books, book chapters, and web sites:

Articles-

Single author:

DEBURH, L.E. 1991. Using *Lemna* to study geometric population growth. *American Biology Teacher* 53(4): 229-32.

Multi-authored:

GREEN, H., GOLDBERG, B., SHWARTZ, M., AND D. BROWN. 1968. The synthesis of collagen during the development of *Xenopus laevis*. *Dev. Biol.* 18: 391-400.

Books-

BOSSEL, H. 1994. *Modeling and Simulation*. A.K. Peters, London. 504p.

Book chapters-

GLASE, J.C. AND M. ZIMMERMAN. 1991. Population ecology: experiments with Protistans. In Beiwenger, J.M. 1993. *Experiments to Teach Ecology*. Ecological Society of America, Washington, D.C. 170p.

Web sites-

MCKELVEY, S. 1995. Malthusian Growth Model. Accessed from <http://www.stolaf.edu/people/mckelvey/envision.dir/malthus.html> on 25 Nov 2005.

Note that for references with more than five authors, note the first five authors followed by *et al.*

F. Tables

Tables should be submitted as individual electronic files. Placement of tables should be indicated within the body of the manuscript. All tables should be accompanied by a descriptive legend using the following format:

TABLE 1. A comparison of student pre-test and post-test scores in a non-majors' biology class.

G. Figures

Figures should be submitted as individual electronic files, either TIFF or BMP. Placement of figures should be indicated within the body of the manuscript. Figures include both graphs and images. All figures should be accompanied by a descriptive legend using the following format:

FIG. 1. Polytene chromosomes of *Drosophila melanogaster*.

III. Letters to the Editor

Letters should be brief (400 words or less) and direct. Letters may be edited for length, clarity, and style. Authors must include institution address, contact phone number, and a signature.

IV. Other Submissions

Reviews and informational submissions may be edited for clarity, length, general interest, and timeliness. Guidelines for citations and references are the same for articles described above.

V. Manuscript Submissions

Article manuscripts may be sent to the current editor either electronically or by hard copy, accompanied by a disc copy. Electronic submissions are preferable. All authors will receive confirmation of the submission within three weeks. Manuscripts should be submitted either as a Microsoft Word or RTF (Rich Text File) to facilitate distribution of the manuscript to reviewers and for revisions. A single-email is required to submit electronically, as the review process is not blind unless requested by an author. If the article has a number of high resolution graphics, separate emails or separate discs mailed to the editor may be required.

If hard copy is sent it must be accompanied by a disc containing the complete submission. Three copies of the manuscript, as well as the original, should be submitted. Standard paper should be used with lines of sections of the manuscripts numbered and enough margin to permit reviewer comments. Two self-addressed stamped envelopes must be included if the authors wish to receive reviews and responses by methods other than email.

VI. Editorial Review and Acceptance

All manuscripts will be sent to two anonymous reviewers as coordinated through the Editorial Board.

Reviewers will examine the submission for:

- **Suitability:** The manuscript relates to teaching biology at the college and university level.
- **Coherence:** The manuscript is well-written with a minimum of typographical errors, spelling and grammatical errors, with the information presented in an organized and thoughtful manner.
- **Novelty:** The manuscript presents new information of interest for college and university biology educators or examines well-known aspects of biology and biology education, such as model organisms or experimental protocols, in a new way.

Once the article has been reviewed, the corresponding author will receive a notification of whether the article has been accepted for publication in *Bioscene*. All notices will be accompanied by suggestions and comments from the reviewers. Acknowledgement of the reviewers' comments and suggestions must be made for resubmission and acceptance. Upon acceptance, the article will appear in *Bioscene* and will be posted on the ACUBE website. The review process can take 4-5 months. Upon final acceptance, the article will appear in *Bioscene* and will be posted on the ACUBE website within six months of publication. Depending upon volume, time from acceptance to publication may take up to a year.

VII. Editorial Policy and Copyright

It is the policy of *Bioscene* that authors retain copyright of their published material.

Call for Nominations for *Bioscene* Editorial Board, Call for Cover Art, and Letters to the Editor for *Bioscene*

We are (constantly) soliciting nominations for three (3) *Bioscene* Editorial Board positions (terms through 2010). Board members provide input in the form of reviews and suggestions concerning the publication of *Bioscene* to the Editor. Board members are also expected to assist in the solicitation of manuscripts and cover art for *Bioscene*. Board members may be called upon to proofread the final copy of *Bioscene* prior to publication and one member will be called upon to act as Book Review editor. **Preference will be given to individuals who regularly attend the annual meeting.** Also, the Editorial Board of *Bioscene* **welcomes cover images and letters to the editor** for future issues of *Bioscene*. Send images and letters according to the image guidelines given in the guidelines for submissions section of this journal to the editor. If you are interested in serving a 3-year term on the Editorial Board or have cover art for consideration, please email the editor, Stephen S. Daggett, at stephen.daggett@avila.edu.

Can a “Reality Check” Improve the Academic Performances of At-Risk Students in Introductory Biology Courses?

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Abstract: To determine how the academic performances of at-risk students in an introductory biology course are affected by a “reality check” describing their probable academic outcomes, I emphasized in some classes only the positive results of good academic choices. In other reality-check classes, I added a discussion of how poor academic choices produce poor academic outcomes such as low grades and low graduation rates. Students in the reality-check classes earned significantly higher grades and attended more lectures, labs, and optional help-sessions than did students in the positive-emphasis classes. These results suggest that a data-based reality-check describing students’ probable academic outcomes can improve the academic performances of at-risk students in an introductory biology course.

Keywords: At-risk students, attendance, help sessions, reality check

Introduction

Students’ academic expectations are often established during the first weeks of a course. For example, Levitz and Noel (1989) note that a “freshman’s most critical transition period occurs during the first two to six weeks,” (p. 66), and Pascarella and Terenzini (1992) have reported that students’ early weeks of class “have profound effects on subsequent levels of involvement and aspirations for intellectual achievement” (p. 4). In light of this, for many years I used the first week of class to stress the positive aspects of students’ academic choices in my introductory biology courses. For example, I emphasized that the highest grades are usually earned by students who regularly attend and participate in class, take advantage of course-related opportunities, and come to course-related activities (e.g., the correlation of class attendance and first-semester GPA is $r [896] = 0.51, p < 0.001$; Moore, 2004b). Although students’ responses to my presentations were usually unremarkable, many students took the message to heart; they came to class regularly, submitted extra-credit work, attended help sessions, and usually made As or Bs. However, the message was lost on many other students, who often skipped class, didn’t do extra-credit work, didn’t respond to academic alerts, didn’t attend help sessions, and usually earned low grades (Moore, 2004a, 2004c). When I discussed this problem with colleagues, I learned that my situation was not unique; similar results typify a variety of other introductory science courses (Moore, et al., 2003).

Why were so many of my students ignoring my and other instructors’ advice about how to succeed? Although I suspected that virtually all first-year students are confident and have high academic expectations early in the semester, their eventual academic outcomes are usually decidedly different; on average, more than one-third of my students earn a D or F, 20% are kicked out of the university after their first year because of poor grades, and fewer than one-third graduate in six years. Similarly poor graduation rates are common in other programs (Boylan, Bonham, & Bliss, 1994). In many instances, these poor outcomes are strongly associated with poor academic choices, and not with a lack of aptitude or non-academic issues (Moore, 2004b). Was I misleading students by emphasizing only the positive aspects of good academic choices? That is, was my emphasis on only the positive outcomes of good academic choices presenting an unrealistic picture of my students’ futures? Would students benefit more if I also gave them a data-based “reality check” that emphasized the negative consequences of poor academic choices?

In this study I investigated whether presenting data-based information about students’ probable academic outcomes would affect students’ academic performances. I also examined how my comments affected students’ performances in a related lab-course that I did not teach to determine if there was a “carry-over effect” of this pedagogical approach to other courses.

Methods

Site of the study and its students. This study was conducted in the General College (GC) of the Twin Cities campus of the University of Minnesota. This study included 1837 at-risk (i.e., developmental) students enrolled in a traditional “mixed majors” introductory biology course from 2002-2006. These students had an average ACT composite score of 19.8 (range = 11-31; for comparison, the national average is 20.9 [ACT scores reveal much, 2006], an average high school rank of 57% (range = 1-99), an average age of 20 (range = 16-52), and a gender distribution of 49% female and 51% male. These students’ ethnic diversity was as follows: 17% African American, 2% American Indian, 16% Asian American, 4% Chicano/Latina, 58% Caucasian, and 3% Other. On average, approximately 10% of students in this course earn an A, 28% earn a B, 29% earn a C, and 33% earn a D or F, and in recent years the six-year graduation rate of this population of students has ranged from 29% to 33%. More information about this course and these students is provided elsewhere (Higbee, Lundell, & Arendale, 2005).

“Positive-emphasis” classes. These classes enrolled 1,016 students. During the first week of the semester I told these students the following information to

In the positive-emphasis classes, I did not stress the negative consequences of poor academic choices at any time. Although these consequences were clear in the data that students received (e.g., students who seldom come to class usually earn a D or F in the course), these consequences were not discussed during the course.

“Reality check” classes. These classes enrolled 821 students. In these classes I discussed all of the positive outcomes of students’ academic choices that were discussed in the positive-emphasis class (see above). However, I also told students the following information as a way of emphasizing the negative consequences of poor academic behaviors.

“I hope all of you do well in this course. However, many of you have unrealistic expectations. If you are like the thousands of other students who have taken this course in recent years, about 95% of you believe you will earn an A or B in this course, about 5% believe you will earn a C, and not one of you believes you will earn a D or F. However, here’s the reality: On average, only about 40% of you will earn an A or B, and about one-third of you will earn a D or F. Many of the students who earn a D or F in this

emphasize the positive outcomes of good academic choices:

“Most of you share a common goal – namely, to graduate from this university. Your being here is evidence that the university believes that you can do this; otherwise, you would not have been admitted. I hope you’re glad to be here. You should be, because there are benefits of graduating from college. For example, college graduates usually earn more money, have lower rates of unemployment, are more likely to vote and volunteer in their community, and are more likely to pursue prestigious careers than people who do not graduate from college.”

These comments were supplemented by quantitative data in the course syllabus about the economic and social benefits of a college education (Education and training pay, 2006).

“One of your first steps to becoming a college graduate is to do well in this course. Your success in this and other courses is strongly influenced by your effort. Indeed, the highest grades are usually earned by students who come to class, attend help sessions, and take advantage of course-related opportunities such as help sessions and extra-credit opportunities.”

Data supporting these claims were included in the course syllabus (e.g., a graph showing the strong correlation of attendance and grades; Moore, 2004b), and students’ first assignment was to write a one-page essay analyzing these data.

course will be in the 20% of students in GC who flunk out of the university every year because of poor grades.” “Look around the room. If you’re like the thousands of students who’ve passed through GC in the past few years, only about one-third of you will graduate from this university. You will spend time here and may generate friendships, lasting memories, and debt, but most of you will not graduate from the university. If graduating from this university is important to you (and I assume that your presence here means that it is), then realize what this means: Two-thirds of you will not accomplish that goal here, regardless of your hopes, dreams, good intentions, and high expectations.”

“Many of you are probably telling yourself that you’ll do whatever it takes to succeed. Many of you will; you’ll work hard, earn good grades, graduate, and enjoy the many benefits of being a college graduate. However, others of you will not. You may have good intentions and high goals, but you’re not graded on your intentions and goals. You are graded on your mastery of the courses’ skills and subject matter.”

“The course syllabus contains important data about how your academic behaviors are associated with your academic outcomes – that is, how what you do affects the grades you make. Read and study the syllabus. Semester after semester these data have been strikingly consistent, and this class will probably not be an exception. There is an important message for you here. Most of you believe that you’ll come to class every day, but attendance will probably average only about 70%. Most of you believe that you will do extra-credit work, but more than two-thirds of you will not. Most of you believe that you’ll come to help sessions, but 75% of you will not. These academic choices – that is, whether you come to class and participate in these course-related activities – are what correlate so strongly with most students’ success or failure. The fact that so many students do not follow through on their academic expectations produces this reality: The odds are against you graduating from this university by almost two-to-one.” Every semester this is the most dramatic part of the course; I have every student’s attention, and there is complete silence as students’ faces blanch with astonished looks. It is clear that students have never been told this information regarding their probable academic futures.

“Some of you may not like to hear this, and may even be mad at me for telling you this information. You may be asking yourself, ‘Why is he telling me that I’ll probably not graduate from this university?’ I’m not trying to make you mad. On the contrary, I’m simply trying to give you a realistic picture of what’s ahead for you in this course and your college career. I’m trying to give you a reality-check, and the reality is that most of you will not graduate from this university. I hope

Carry-over. To determine if the impact of this approach carried over to other courses in which I was not directly involved, I measured students’ attendance in a laboratory course in which students enrolled concurrently with my course. That course, which met once per week, was taught by different instructors.

What I studied. I measured the following academic behaviors and outcomes:

1. Attendance at lectures and labs. I recorded attendance at every lecture and lab. Lecture attendance was monitored with short in-class writing assignments in each class. Lab attendance was

that this prompts you to ask yourself a simple but important question: ‘How can I improve my odds of succeeding in this course and thereby being in the one-third of students who will graduate from the university?’ There are no guarantees, but there is a simple thing you can do that will dramatically improve your chances of success: Work hard and engage yourself with your education. If you do this, you’ll have a much better chance of accomplishing your goals and graduating from this university.”

“There’s some good news here. Many of you will heed this advice; you’ll come to class and other course-related activities, and will probably do well in this course. If you end up in this group, the advice that I’ve just given you is the best advice you’ll get while you’re at this university. However, for others of you, what I’ve just said won’t matter. You think that these data don’t apply to you, that you’re guaranteed success here because you made pretty good grades in high school, and that you can do well in this and other courses without trying very hard. Perhaps you can, but the odds are that you can’t. The sad truth is that many of you, after skipping classes, not coming to help sessions, not doing extra-credit work, and generally just not working very hard, will come to my office late in the semester and ask what you can do to avoid failing my class and, in some cases, being kicked out of the university. This happens every semester, just like clockwork. I’m giving you the answer now: Get involved and take personal responsibility for your education.” I then began the course.

All sections were offered during mid-day hours and were taught by the same instructor in the same way (i.e., the same grading criteria, textbook, course policies).

recorded by teaching assistants; students were considered absent if they arrived more than 30 minutes late. Students received no points for coming to lectures or labs.

2. Attendance at help-sessions. The semester included four help sessions that were conducted by teaching assistants who had no knowledge of, or input regarding, any of the exams. Attendance, which was taken at each help session, was optional, and students who attended the sessions received no points or “inside information” about upcoming exams. The dates, times, and places of help sessions were announced on the first day of classes and were included in the course syllabus.

3. Submission of extra-credit work. Students could earn one-third of the points that they missed on each lecture exam if they submitted a typed, one-page essay about each of the questions that they missed on the exam. Students had six weeks to write and submit the essays, and the extra-credit points were guaranteed for any reasonable effort. Points earned by students who submitted extra-credit work were excluded from all calculations of grades in this study.

Students' attitudes and expectations. At the beginning of the first day of class, I administered a survey that asked for students' responses to the following: (a) High school prepared me well for the academic challenges of college. (b) I am confident that I will graduate from college within five years. (c) I will attend ___% of classes. (d) I will attend at least one help session during the semester. (e) I will do at least one extra-credit assignment during the semester. (f) I will earn a(n) ___ in this course. Responses were anonymous, optional, and tallied after final grades were submitted.

On the second day of class, I administered another survey. In the positive-emphasis classes, this survey was as follows: "On the first day of class I told you that good grades are usually associated with good academic choices

(e.g., coming to class regularly). Have you heard this information before at the university?" In the reality-check classes, this survey was as follows: "On the first day of class I told you that good grades are usually associated with good academic choices (e.g., coming to class regularly), and that poor grades usually accompany poor academic choices. I also showed you data documenting that only about one-third of students in GC graduate from the University of Minnesota. Have you heard this information before? (a) I've been told by other instructors or advisors that I'll probably make better grades if I come to class regularly, do extra-credit work, and attend help sessions. (b) I've been told by other instructors or advisors that I'll probably make poor grades if I skip lots of classes and ignore course-related opportunities. (c) I've been told by other instructors or advisors that the odds are against me graduating from the University of Minnesota."

Students who were not at the first class were instructed not to complete the survey. Surveys were anonymous and were not tallied until after all grades were submitted. I used institutional data to obtain students' high school GPAs and their grades in their high school biology courses.

Results

The average high-school GPA of students in the positive-emphasis classes was 3.19, and that of students in the reality-check classes was 3.16. These GPAs were not significantly different. In their high school biology classes, 35% of the students in this study had earned an A, 56% had earned a B, 9% had earned a C, and none had earned a D or F. These percentages were similar in the positive-emphasis and reality-check classes.

On the survey administered on the first day of class, large majorities of students in all sections were confident that they would graduate in five years, attend class at least 90% of the time, attend at least one help session, and do at least one extra-credit assignment (Table 1). On the survey administered on the second day of classes, 87% of the students in the positive-emphasis classes (and 91% of students in the reality-check classes) said that

other instructors or advisors had told them that they would probably make better grades if they came to class regularly, did extra-credit work, and attended help sessions. A smaller percentage (i.e., 41%) of students reported that other instructors or advisors had told them that they would probably make poor grades if they skipped lots of classes and ignored course-related opportunities. Only 4% of students reported that they had been told that they were at-risk for academic failure and were unlikely to graduate from the University of Minnesota.

Table 1 shows students' predicted behaviors and grades, as well as their actual behaviors and grades. Students in the reality-check classes attended significantly more lectures, labs, and help sessions than students in the positive-emphasis classes. Students in the reality-check classes also did more extra-credit work and earned significantly higher grades than students in the positive-emphasis classes.

TABLE 1. Students' average grades, predicted rates of class attendance, and first-day-of-classes predictions about their academic work in the positive and "reality check" classes.

	Positive <u>Emphasis</u>	Reality <u>Check</u>
Sample size	1,016	821

Students' predictions

High school prepared me well for the academic challenges of college.	81	80
I am confident that I will graduate from college within five years.	95	96
I will attend ____% of my classes.	91	89
I will attend at least one help-session.	89	86
I will do at least one extra-credit assignment.	97	96
I will earn a ____ in this course.		
% A – B – C – D – F	53-43-4-0-0	50-44-6-0-0

Students' outcomes

Attendance rate, % of classes attended	69 ± 1.3	74 ± 1.9*
Course grade, %	70 ± 0.6	74 ± 0.5*
Attended at least one help-session, %	23	32*
Did at least one extra-credit assignment, %	24	31*
Students who missed no labs, %	72	80*
Grade distribution		
% A – B – C – D – F	8-27-28-17-20	9-31-33-15-12

* Mean is significantly different from the mean of the “positive emphasis” class (i.e., $p < 0.05$).

Discussion

My presentations of positive-emphasis information produced respectful but disinterested responses from my students. No students questioned this information, presumably because they had heard this kind of advice before. However, my presentations of the “reality check” information (i.e., information about students’ probable grades in my course and their poor odds of graduating from the university) produced the most attentive responses I’ve ever elicited at any time in any course that I’ve ever taught. Every student listened intently (many with astonished looks on their faces), and no student talked, read newspapers, or shuffled papers. Several students came to my office during office hours and commented about the presentations (e.g., “You really got my attention”). These responses suggested to me

that many of the students were not aware of these data and had never been told this information.

This conclusion was emphasized by students’ responses to the survey questions. For example, virtually none of the students had ever been told of their likely academic outcomes, and virtually none considered themselves to be at-risk for low grades or for not graduating from the university. On the contrary, virtually all students believed that they would graduate within five years, when, in reality, only one-third would graduate within six years. Taken together, these results indicate that many at-risk students have major misconceptions about their probable academic outcomes and do not understand that they are at-risk for academic failure in college.

This conclusion is also supported by the fact that 80% of students claimed that they were well-prepared for the academic challenges of college.

When I asked students why they felt well-prepared, most mentioned that they had made “good,” “pretty good,” or “okay” grades in high school. They were right; they *had* made good grades in high school. After all, their high school GPAs exceeded 3.0, and more than 90% of the students had earned an A or B in their high school biology course. These results are not unique to the University of Minnesota. Indeed, despite having the worst study habits on record, today’s undergraduates have the highest high school grades on record (Cavanagh, 2004; Sax, et al., 2002; Young, 2002; Young & Sowa, 2002), and many students mistakenly believe that the same amount of effort in college as in high school will produce good grades (Toppo, 2005). Even at-risk students are accustomed to making relatively high grades in high school. In light of this, it is not surprising that they are confident and do not consider themselves to be at-risk for failing. Would giving students a first-week-of-class “reality check” make any difference?

In the reality-check classes, attendance was significantly higher than in the positive-emphasis classes (69% vs. 74% in the positive-emphasis and reality-check classes, respectively). These results suggest that a data-based reality-check can improve students’ average rates of class attendance. This improvement in class attendance was associated with significantly higher grades in the reality-check classes. As has been reported earlier for non-developmental education students (Launius, 1997), students who came to class most often made the highest grades. These results support conclusions of earlier studies regarding a strong beneficial impact of class attendance on course grades of at-risk students (Launius, 1997; Moore, 2005), and suggest that presentations of data-based reality-check information can improve students’ grades in introductory biology classes.

2. During the first week of classes, discuss with students the data showing how academic behaviors (e.g., coming to class and help sessions) are associated with grades in the course they’re taking. Although data about graduation rates can help students see the long-term picture, data showing how their academic choices affect their grades in individual courses help students understand the consequences of their short-term decisions (e.g., should I go to class today?).

3. Use quantitative data from previous classes to show students the distributions of grades and how students’ behaviors are associated with various grades. Quantitative data are much more effective

Although I tried to teach all sections of the course the same way, I was not blind to which of the two types of the course a specific section was, and may have unintentionally “tried harder” in the “reality check” sections (and thus delivered better instruction). Of course, I cannot completely rule this out. However, the improved academic behaviors and grades associated with the reality-check classes also carried-over into a lab course in which the students were enrolled that I did not teach. For example, students in the reality-check classes missed fewer labs than did students in the positive-emphasis classes. These improved rates of class attendance in lab were also associated with higher attendance rates at help sessions and greater participation in extra-credit assignments (Table 1). These results suggest that a “reality check” such as the one described here can influence a variety of academic behaviors that are associated with better grades in introductory biology courses.

Research into Practice

Biology instructors whose classes include at-risk students might be able to improve the academic behaviors and grades of some of their students by considering the following suggestions:

1. During the first week of classes, discuss with students the data summarizing their probable academic outcomes (e.g., especially relative to their grades and graduation rates). These data have an impact because most students have never seen these data and do not realize that they are at-risk for failure. On the contrary, they’ve always earned relatively high grades, and flunking out of school has never occurred to them. Nevertheless, many of them will not graduate. Showing students these data has a sobering affect and, more importantly, a significant impact on the academic performances of many students.

than generalities such as “It is important to work hard in this class.” Students have heard these generalities before, and many of them are not impressed.

4. During the first week of classes, require students to write about these data. This forces students to interpret data and confront a conclusion that will help some of them be better students – namely, that their grades and academic futures are closely related to their effort, and are therefore under students’ control.

Implementing these recommendations won’t help every student; significant percentages of students in both classes ignored my advice and skipped classes, skipped help sessions, and did not do extra-credit

work, regardless of what I emphasized during the first week of class. These results are consistent with previous reports that many at-risk students (a) do not follow through on their academic expectations, and (b) have behaviors that are inconsistent with academic success (Pintrich & Garcia, 1994; VanZile-Tamsen & Livingston, 1999; Yaworski, Weber, & Ibrahim, 2000). Many at-risk students assume that the same behaviors that produced good grades in high school will produce similarly high grades in college.

References

- ACT scores reveal much about college readiness. 2006. Accessed from <http://www.ohe.state.mn.us/mPg.cfm?pageID=792> on March 30, 2006.
- BOYLAN, H.R., BONHAM, B.S., AND BLISS, L.B. 1994. Who are the developmental students? *Research in Developmental Education* 11(2): 1-4.
- CAVANAGH, S. 2004. Students ill-prepared for college, ACT warns. *Education Week* 24(8): 5.
- EDUCATION AND TRAINING PAY. 2006. Accessed from <http://www.postsecondary.org> on April 14, 2006.
- HIGBEE, J.L., LUNDELL, D.B., AND ARENDALE, D.R. 2006. *The General College Vision: Integrating Intellectual Growth, Multicultural Perspectives, and Student Development*. Minneapolis, MN: Center for Research on Developmental Education and Urban Literacy, General College, University of Minnesota. 579 p.
- LAUNIUS, M.H. 1997. College student attendance: Attitudes and academic performance. *College Student Journal* 31: 86-92.
- LEVITZ, R., AND NOEL, L. (1989). Connecting students to institutions: Keys to retention and success. In Upcraft, M.L. Upcraft, Gardner, J.N., and Associates. *The Freshman Year Experience* (pp. 65-81). San Francisco, Jossey-Bass. 160 p.
- MOORE, R. 2002. The fates of developmental education students at two-year and four-year colleges. In Higbee, J.L. Higbee, Lundell, D.B., and Duranczyk, I.M. *Developmental Education, Policy and Practice* (pp. 55-64). Auburn, CA: National Association for Developmental Education. 152 pp.
- MOORE, R. 2004a. Does improving developmental education students' understanding of the importance of class attendance improve students' attendance and academic performance? *Research in Teaching of Developmental Education* 20(2): 24-39.
- MOORE, R. 2004b. The importance of a good start. In Duranczyk, I., Higbee, J., and Lundell, D. *Best Practices for Access and Retention in Higher Education* (pp. 115-124). Minneapolis, MN: Center for Research on Developmental Education and Urban Literacy, General College, University of Minnesota. 170 p.
- MOORE, R. 2004c. Who is helped by help sessions in developmental education? *Research & Teaching in Developmental Education* 21(1): 50-56.
- MOORE, R. 2005. Pre-enrollment and post-enrollment predictors of the academic success of developmental education students. *Journal of College Student Retention* 6(3): 325-335
- MOORE, R., JENSEN, M., HATCH, J., DURANCZYK, I., STAATS, S., AND KOCH, L. 2003. Showing up: The importance of class attendance for academic success in introductory science courses. *The American Biology Teacher* 65(5): 325-329.
- PASCARELLA, E.T., AND TEREZINI, P.T. 1992. Designing colleges for greater learning. *Planning for Higher Education* 20: 1-6.
- PINTRICH, P.R., AND GARCIA, T. 1994. Self-regulated learning in college students: Knowledge, strategies and motivation. In Pintrich, P.R. and Brown, D.R. *Student Motivation, Cognition and Learning: Essays in Honor of Wilbur J. McKeachie*. (pp. 113-133). Hillsdale, NJ: Erlbaum. 287 p.
- SAX, L.J., LINDHOLM, J.A., ASTIN, A.W., KORN, W.S., AND MAHONEY, K.M. 2002. *The American freshman: National norms for Fall 2002*. Los Angeles, CA: Higher Education Research Institute. 141 p.
- TOPPO, G. 2005, February 2. Reality weighs down dreams of college. *USA Today*, pp. 1A, 2A.
- VANZILE-TAMSEN, C., AND LIVINGSTON, J.A. 1999. The differential impact of motivation on the self-regulated strategy use of high- and low-achieving college students. *Journal of College Student Development* 40(1): 54-60.
- YAWORSKI, J., WEBER, R.M., AND IBRAHIM, N. 2000. What makes students succeed or fail? The voices of developmental college students. *Journal of College Reading and Learning* 30(2): 195-221.
- YOUNG, B.D., AND SOWA, C.J. 1992. Predictors of academic success for Black student athletes. *Journal of College Student Development* 33: 318-324.
- YOUNG, J.R. 2002. Homework? What homework? *The Chronicle of Higher Education* 49(15): A35-A37

The Use of Crayfish in Determining Water Quality: Adapting a Summer Undergraduate Research Project into Laboratory Teaching Modules

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Abstract: A bioassay using crayfish was developed by a team of undergraduate summer research students to analyze water in a stream located next to a closed hazardous waste dumpsite near the Missouri River in St. Joseph Missouri. In this report, we review the processes of science utilized by this team of students in completing this project and present an overview of the value and justification for adapting this project into laboratory teaching modules.

Keywords: bioassays, applied learning, undergraduate research

Introduction

Missouri Western State University has a strong history of supporting applied learning and undergraduate research, especially in biology and chemistry. The departments of biology and chemistry are instrumental in the support of undergraduate research programs including the Undergraduate Research Summer Institute (URSI) and the Summer Research Institute (SRI). The SRI program in particular provides support and resources for teams consisting of a faculty member, one upper level undergraduate, and up to three area high school students to conduct research over the summer. This paper briefly describes and outlines the results of a SRI-funded project conducted through the Department of Biology during the summer of 2005.

The focus of the applications for the 2005 SRI was "Economic Development." Thus, the specific aim of the project application submitted by the authors involved determining the feasibility of monitoring environmental stress experienced by aquatic organisms as a result of the economic development of a region using changes in the expression of known molecular and cellular markers.

The undergraduate team member (Talley) worked on adapting the protocols of bioassays performed in the MWSU teaching laboratories of cell and molecular biology and animal physiology. In these bioassays, zebrafish embryos are used as the model organism for investigating the molecular and physiological changes that occur during early zebrafish development following exposure to various pharmaceuticals and personal care products (PPCPs)

and hazardous chemicals such as heavy metals, under controlled laboratory conditions (Daggett, 2007).

The SRI student team members developed an experimental plan in which the zebrafish, which are native to fresh water streams in India, are replaced by native crayfish that were collected near the residence of a team member (coauthor Lee). Students successfully collaborated in altering the experimental design of the bioassay protocols, used for testing zebrafish embryos in the laboratory, to allow testing of water found outside the laboratory. This ultimately led to fulfilling the project's specific aim of developing a biologically-based assay (bioassay) for testing bodies of water in and around St. Joseph, MO for compounds that could alter some measurable biological activity. Specifically, this project tested a biomarker system to determine if any of the wastes previously deposited in the landfill could be detected through effects on altered gene expression in crayfish placed at specific sites in the neighboring stream known as Roy's Branch.

Upon completion of this project, student team members had engaged in most of the processes of science recommended by the American Association for the Advancement of Science (1989) including; making observations, measuring, classifying and interpreting data, formulating and testing hypotheses, and most significantly in communicating results. During the following year, the faculty member and students presented the results of this study at more than six local, regional and national meetings including the Ecological Genomics Symposium in Kansas, the Missouri Natural Resources Conference, the Centennial meeting of the

American Society of Biochemistry and Molecular Biology, and the 2006 Biennial National Convention of Beta Beta Beta National Biological Honor Society (Talley and Daggett, 2006). The project also helped make students aware of how past and present effects of economic activity within a region can alter the environment and the potential consequences these alterations have on the health of the ecosystem and the organisms that live there, including humans.

Project Background: Economically active regions of the United States produce, accumulate, and dispose of large quantities of known hazardous wastes. One strategy for disposing of hazardous waste is to bury the waste in a designated landfill. One such landfill, located along the Missouri River in St. Joseph MO, collected waste for burial during the last half of the 20th century (Figure 1). This landfill was closed, capped with loess clay and surfaced with asphalt around 1997. This project tested a biomarker system to determine if any of the wastes previously deposited in the landfill could be detected through effects on altered gene expression in crayfish placed at specific sites in the neighboring stream known as Roy's Branch. Biomarkers, such as changes in the expression level of specific genes, are increasingly being used to monitor for environmental pollutants since they are extremely sensitive and can be used to directly assay an adverse biological response. Crayfish, the organism used in this study, are naturally occurring organisms in Missouri's streams and rivers and have previously been used to monitor water quality around the world (Triebkorn et al., 2002; Cimino et al., 2002; Otero et al., 2006; Schilderman et al., 1999)

Materials and Methods

Crayfish were collected from a rural area near Winston, Missouri, transported to Missouri Western State University in St. Joseph, Missouri and maintained in the laboratory in a large aquarium using dechlorinated tap water for at least 3 weeks before being used in the study. Individual experimental crates measuring 10 x 10 x 20 cm were designed, and constructed using galvanized mesh screens. On day one of the study, one male and one female crayfish were placed in each of four crates and transported out to the experimental site. Each crate was submerged in water at four different sites

along Roy's Branch (Figure 1). After four days, crayfish at each site were removed from each crate and placed on ice to be transported back to the laboratory.

In the laboratory, on the return date, the crayfish were dissected with tissue from the cephalothorax (C) and tail (T) region pooled according to the site being tested. Tissue samples were homogenized on ice in 80 mM PIPES/K⁺, 1 mM MgSO₄, 1 mM EGTA, pH 6.9 containing 1X protease inhibitor cocktail (Sigma P-8340), using a Kontes (7 ml) tissue disruptor. The homogenates were centrifuged at 2,000 x g (Eppendorf A-4-62 swinging bucket rotor) for 30 minutes at 4°C. Supernatants were removed and stored at -20°C. Protein concentration was determined by the bicinchoninic acid (BCA) assay kit (Pierce) using bovine serum albumin (BSA) as a standard.

Supernatants were loaded onto 10% SDS-denaturing polyacrylamide gels at 30 ug protein per lane. Lane one contained 10 uls of BlueRanger® Prestained Protein Molecular Weight Marker Mix (Pierce) and lane 10 contained mouse brain extracts as a positive control for alpha-tubulin expression. Gels were run at 200V for 40 minutes. Following electrophoresis, gels were stained with Coomassie Blue or transferred to Immobilon P Transfer Membrane (Millipore) according to the manufacturers instructions. Blotted membranes were blocked in Tris-buffered saline (100 mM TrisCl, pH 7.4, 0.9% NaCl), containing 0.5 % Tween-20 (TTBS) and 10% Carnation instant milk for 60 minutes at room temperature. The primary antibody, mouse anti-alpha-tubulin IgG, clone B-5-1-2, (Sigma T5168) was applied at 1:5,000 dilution in TTBS/milk overnight at 4°C with shaking then washed 4 x 15 minutes in TTBS. The secondary antibody, alkaline phosphatase conjugated to goat anti-mouse IgG (Zymed Laboratories, 81-6122) was applied at 1:5,000 dilution in TTBS for 2 hours at room temperature then washed 4 x 15 minutes in TTBS. Visualization of alkaline phosphatase using BCIP/NBT Purple Liquid Substrate for Membranes (Sigma B3679) was applied for 15 minutes at room temperature, allowing the detection of bands indicating the presence of alpha-tubulin. The reaction was stopped by rinsing briefly with distilled water.

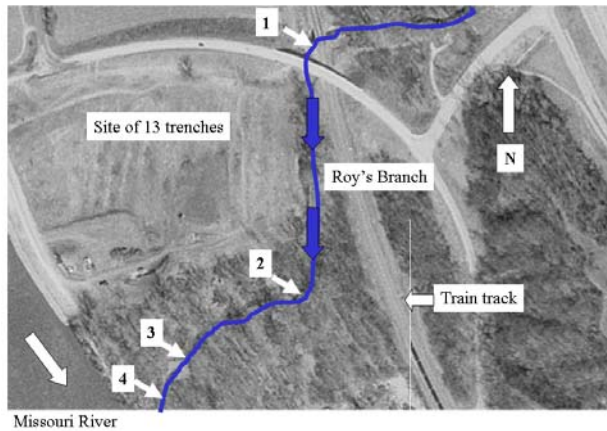


FIG 1. Aerial view of experimental sites 1, 2, 3 and 4 along Roy's Branch. The aerial photograph was taken in 1997 before the waste trenches were capped and surfaced with asphalt. Photo was obtained from Interactive MAP at <http://maproom.missouri.edu/>.

Results

The results of the summer undergraduate research project that utilized crayfish as an experimental model organism indicated differences in gene expression based on the site in which the

crayfish were placed. Figure 1 shows an aerial view of the experimental site that reveals the locations of the 13 trenches that served as a hazardous waste dump that has since been capped and overlaid with asphalt. Indicated on Figure 1 are the four sites along Roy's Branch in which crayfish were placed. Site one served as a control and is located upstream of the covered waste dump. Sites 2, 3, and 4 were located at various points along Roy' Branch downstream of the dumpsite to where it empties out into the Missouri River.

Figure 2 shows a SDS-denaturing polyacrylamide gel and corresponding Western blot probed with a monoclonal antibody specific for alpha-tubulin. Several proteins observed on the Coomassie Blue stained polyacrylamide gel (indicated by the arrows) were expressed at a higher level in crayfish placed at sites 2, 3, and 4 relative to the expression levels seen from crayfish placed at site 1. The expression of alpha-tubulin, a subunit of the tubulin heterodimer that makes up the microtubule cytoskeleton, appears to be up-regulated in the tail tissue of crayfish placed at sites 2, 3, and 4 compared to those placed at site one.

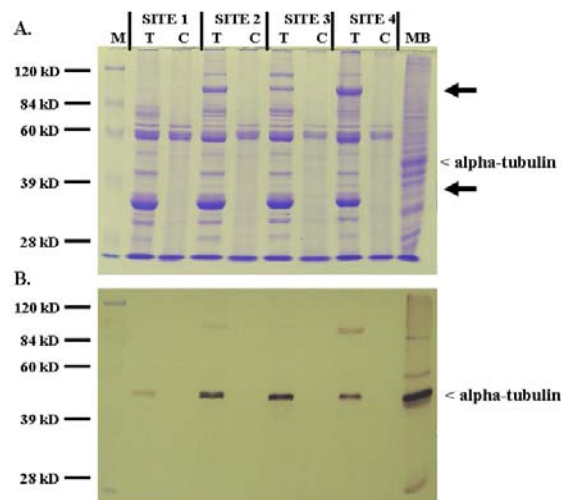


FIG 2. Protein expression profiles from crayfish tissues placed at different sites along Roy's Branch. A: SDS-PAGE of tissue extracts from the tail (T) and cephalothorax (C) regions of crayfish from sites 1, 2, 3, and 4. Lane M, molecular weight markers; Lane MB, mouse brain extract. Two unknown proteins are expressed at higher level in the tail regions of crayfish from sites 2-4 compared to the crayfish located at site 1 (arrows). B: Corresponding immunoblot probed with a monoclonal antibody against alpha-tubulin. Higher levels of alpha-tubulin are expressed in the tail regions of crayfish from sites 2-4 compared to the crayfish located at site 1.

Discussion

Biomarkers are increasingly being used to monitor adverse biological responses in the

environment (Triebkorn et al., 2002). Genes products such as metallothionein, heat shock proteins and glutathione S-transferase have been observed to be up-regulated in response to specific chemical exposures (Mattingly et al., 2001 and Mattingly et al., 2006). We have identified several proteins up-regulated in crayfish placed at different locations along a potentially contaminated stream near the Missouri River in St. Joseph, Missouri. A particularly interesting finding was the apparent increased expression of alpha-tubulin at sites recognized for containing hazardous materials. The surface soil and groundwater near sites 2, 3, and 4 are known to contain elevated levels of benzidine, chlordane and 4-4, DDT (unpublished data). Beaty et al. (2002) reported on the increased expression of alpha-tubulin in the midgut epithelium of aquatic arthropods following exposure to elevated heavy metals. It is possible that sites 2, 3, and 4 also contain elevated levels of heavy metals such as cadmium, based on the history of regional industrial activity. An initial conclusion from this project is that it is feasible to monitor environmental stress, such as exposure to hazardous wastes, experienced by aquatic organisms during the economic development of a region by monitoring changes in the expression of known molecular and cellular markers.

In addition to our initial conclusion, the progression of this project during the summer, revealed a number of specific cell biology and biochemical skills and techniques, that required students to accurately perform their designed experiments in an independent manner that would be highly valued in a biology graduate pursuing work either as a graduate student or as a laboratory technician. This led to the development of a collaborative study between faculty in the biology and chemistry departments to quantify the level of proficiency our students have in performing specific skills following two courses required by all biology degree programs at MWSU, BIO 215 Molecular Cell Biology and CHE 370 Biochemistry. This study acknowledges the need that exists in biology and chemistry curriculums for identifying, quantifying and assessing the proficiency levels of students in the performance of basic skills in biology and biochemistry laboratories (Boyer, 2003; Caldwell et al., 2004). Following one year of data collection, analysis revealed a significant number of our students lacked a basic level of proficiency in laboratory skills associated with identifying the dependent and independent variables in an experiment, the ability to properly graph experimental data, make a buffer, and/or correctly use laboratory instruments such as analytical scales, micropipettors, pH meters, microscopes, spectrophotometers and centrifuges

(Daggett and Caldwell, 2006). We found that students were often familiar with the basic use of the instruments, but did not know how to accurately obtain quantitative data from the instruments through calibration techniques and/or the preparation of standard curves. This may suggest that in laboratories in which students work in collaborative groups, students are relying heavily on one member of the group and that current methods of assessing individual student proficiency may need to be revised and a more individualized form of assessment developed.

TABLE 1. Outline of Skills to be assessed.

-
- I. Experimental design
 - II. Preparation of solutions
 - A. required mathematical calculations
 - B. calibration and use of an analytical scale
 - C. calibration and use of a pH meter
 - D. identification and costs of laboratory supplies
 - III. Preparation of biological samples
 - A. writing dissection protocols
 - B. tissue disruption and homogenization
 - C. centrifugation
 - IV. Protein assays
 - A. calibration and use of a micropipettor
 - B. spectrophotometry
 - C. centrifugation
 - V. Molecular separations
 - A. SDS-PAGE
 - VI. Immunological Assays
 - A. Western blotting
 - VII. Documentation of results
 - VIII. Presentations
 - A. constructing a poster
 - B. writing a report
 - C. oral presentations
-

A research project such as the one presented here has been adapted into a number of smaller teaching modules as outlined in Table 1 that are being used in a semester long molecular cell biology course in order to identify, quantify and assess student performance in the laboratory. The results of this altered laboratory format on student performance during the spring 2007 semester is currently being analyzed and will be used to continue making improvements in assessing student performance in the teaching laboratory. A noted highlight of the modified spring 2007 BIO 215 Molecular Cell Biology laboratory was the further modification of the crayfish project in which water samples from the four stream sites were brought back into the lab and utilized in the original zebrafish bioassay protocols.

Preliminary results indicate similar alterations in alpha-tubulin expression in 7-day-old zebrafish larvae as those seen in the crayfish (Lee and Treece, unpublished data).

In conclusion, thematic undergraduate summer research programs such as the Summer Research Institute at MWSU, allow students and faculty the opportunity to merge both scientific inquiry with insight into assessing and improving pedagogical techniques

References

- AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. 1989. *Science for All Americans*. Washington, DC: AAAS.
- ALCORIO, P., OTERO, M., CREHUET, M., BALTANAS, A., AND C. MONTES. 2006. The use of the red swamp crayfish (*Procambarus clarkii*, Girard) as indicator of the bioavailability of heavy metals in environmental monitoring in the River Guadiamar (SW, Spain). *Sci Total Environ.* 366(1): 380-390.
- BEATY, B., MACKIE, R., MATTINGLY, K., CARLSON, J., AND A. RAYMS-KELLER. 2002. The midgut epithelium of aquatic arthropods: a critical target organ in environmental toxicology. *Environ. Health. Perspect.* 110: 911-914.
- BOYER, R. 2003. Concepts and skills in the biochemistry/molecular biology lab. *BAMBED* 31(2): 105-105.
- DAGGETT, M. A. F. 2007. The use of adult and embryonic zebrafish in extending bioassays in undergraduate research projects. *FASEB J.* 2007 21:478.14 (Abstract)
- DAGGETT, M. A. F. AND B. D. CALDWELL. 2006. Design and implementation of skill-specific assessments in introductory and advanced cell biology and biochemistry courses. *FASEB J.* 2006 20:A16 (Abstract)
- CALDWELL, B., ROHLMAN, C., AND M. BENORE-PARSONS. 2004. A curriculum skills matrix for development and assessment of undergraduate biochemistry and molecular biology laboratory programs. *BAMBED.* 32(1): 11-16.
- CIMINO, E., OWENS, L., BROMAGE, E., AND T. ANDERSON. 2002. A newly developed ELISA showing the effect of environmental stress on levels of hsp86 in *Cherax quadricarinatus* and *Penaeus monodon*. *Comp. Biochem. Physiol. A* 132: 591-598.
- MATTINGLY, K. S., BEATY, B. J., MACKIE, R. S., MCGAW, M., CARLSON, J. O., RAYMS-KELLER, A. 2001. Molecular cloning and characterization of a metal responsive *Chironomus tentans* alpha-tubulin cDNA. *Aquat Toxicol.* 2001 Oct;54(3-4):249-60.
- MATTINGLY, C. J., ROSENSTEIN, M. C., COLBY, G. T., FORREST, J. N. JR., AND J. L. BOYER. 2006. The comparative toxicogenomics database (CTD): a resource for comparative toxicological studies. *J. Exp. Zoolol A Comp Exp Biol.* 305(9): 689-692.
- NATIONAL RESEARCH COUNCIL. 2003. *Bio2010: Transforming Undergraduate Education for Future Research Biologists/ Committee on Undergraduate Biology Education to Prepare Research Scientists for the 21st Century*. National Academies Press. Washington, D. C.
- SCHILDERSMAN, P. A., MOONEN, E. J., MAAS, L. M., WELLE, I., AND J. C. KLEINJANS. 1999. Use of crayfish in biomonitoring studies of environmental pollution of the river Meuse. *Ecotoxicol Environ Saf.* 44(3): 241-252.
- TALLEY, N. L. AND M. A. F. DAGGETT. 2006. Determination of small stream water quality using crayfish as a model organism. *FASEB J.* 2006 20:A67 (Abstract)
- TRIEBSKORN, R., ADAM, S., CASPER, H., HONNEN, W., PAWERT, M., SCHRAMM, M., SCHWAIGER, J., AND H. KOHLER. 2002. Biomarkers as diagnostic tools for evaluating effects of unknown past water quality conditions on stream organisms. *Ecotoxicology* 11: 451-465.

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Research Experience for Undergraduates: A Student's Reflection on an Authentic Learning Experience

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Abstract: Experience with research is a valuable component in the growth of undergraduate students. Federal funding is available to provide this experience. Through research experiences, undergraduates have an opportunity to work under the mentorship of an experienced researcher, sample research as a career choice, and establish a network of collegial friendships with like-minded students. Beyond these obvious benefits, however, undergraduate research experience can nurture authentic growth toward a deeper appreciation of science as a way of knowing. Posing a question, followed by designing and performing procedures to obtain an answer, involves students in an exciting process. *Doing science* takes learning to another level.

Keywords: Research Experience for Undergraduates (REU).

Introduction

A cupola crowns the third story of the appealing century-old building, one in a set of imposing white structures standing at the water's edge of Great Bay on the south coast of New Jersey. Formerly a U.S. Coast Guard Station, the historic complex now houses the Rutgers University Marine Field Station and is headquarters for the Jacques Cousteau National Estuarine Research Reserve—the least disturbed estuarine ecosystem in the densely populated Boston-New York-Philadelphia-Washington, D.C. corridor.

The field station is a full-function marine bioresearch facility. Multi-disciplinary research groups of the Rutgers Institute of Marine and Coastal Sciences conduct oceanographic research at the field station in areas that include deep-sea ecology, and environmental biophysics. Much of the work at the field station focuses on the life history, ecology, and behavior of fishes, with emphasis on habitat utilization in both the estuary and the canyons of the continental shelf. With immediate access to the Atlantic Ocean, the field station's adjacent boat basin, is port to a fleet of research vessels for work on the bay and coastal ocean. A nearby dormitory serves as residence for students and visiting scientists. Last summer, I was privileged to participate in a *Research Experience for Undergraduates* internship at this marine field station.

The REU Program

The Research Experience for Undergraduates (REU) internship program is a ten-week summer internship funded by the National

Science Foundation (NSF). This program provides undergraduate students from all over the USA the opportunity to design and conduct an original research project under the mentorship of an experienced research scientist. REU opportunities are available in a wide variety of scientific fields, including astronomy, biology, oceanography, and physics. REU sites are generally associated with universities. Most sites host about 10 interns each summer. Although there can be small site-to-site variations, REU interns usually receive travel support, free housing and a generous stipend. Often, there is the opportunity to earn college credit for the REU experience.

My summer as a research intern at the Rutgers Marine Field Station began with the selection of a research project. After a get-acquainted barbeque, mentors and interns set down the next day to the task of defining the summer's work. The application process had matched the interests of interns and mentors, so project discussions rested on reasonably common ground. In a few cases, projects were significantly influenced by an intern's specific qualifications, e.g. SCUBA certification.

Based on the interests I had expressed in my application essay, I was matched with two researchers who were conducting fish tracking studies. This sounded to me like adventurous, on-the-water research and I was happy to learn that I would not spend the summer in a laboratory pipetting endless samples into culture dishes. The interest profiles of two other interns had identified them as on-the-water types also, so the three of us shared the same mentors. Within the framework of their fish tracking research, our mentors guided us toward areas of potential study. Much our discussions focused on gaps in the research.

My project took shape around a significant gap in the knowledge of stripe bass habitat utilization. Striped bass spawn in the upstream fresh water of coastal rivers. Young striped bass gradually move down rivers, through bays and eventually out into coastal saltwater habitats. Along this route, coastal estuaries serve as nurseries for the sub-adult (defined as less than 22 inches long) striped bass. Periodic declines in the stripe bass population highlighted the importance of proper management of young fish within a nursery habitat, yet the freshwater to salt water movement of sub-adult striped bass was an incompletely understood transition. Are the young fish resident within a discernible segment of the estuary or transient throughout the entire estuarine ecosystem? Do different temperature and salinity requirements cause a spatial separation between the adult and sub-adult striped bass populations? These were important questions that had not yet to be studied. Following an intense weeklong review of the literature, interns wrote formal research proposals. My proposal was titled "Movement of Sub-Adult Striped Bass (*Morone saxatilis*) within an Estuarine Ecosystem."

Defining our projects was a congenial, bilateral process. Mentors had guided us and provided valuable judgments concerning feasibility, time frames and sample sizes, but we had chosen our own projects. REU guidelines stress that an intern's research be neither a practice nor an exercise and emphasize the *original* aspect of the research. By collecting data on the movement of sub-adult striped bass and analyzing how these movements compared with those of previously studied adults of the species, my project could contribute to a better understanding of the management of a valuable natural resource. I felt my research had the potential to make a distinct, and important contribution to science. I liked that idea.

The summer REU program immerses interns in a variety of research activities. They gather field samples, perform lab tasks, analyze data, and learn how to operate specialized research equipment. It is an excellent way for undergraduate students to gain field and laboratory experience that is considerably beyond what they have been exposed to in their regular science courses.

My tracking project involved catching fish, surgically implanting acoustic transmitters into their abdominal cavities, tracking the movements of the tagged fish and analyzing the data. It was a very "hands-on" project. After a demonstration of procedures (surgical implantation) and equipment (transmitters, hand-held hydrophone, salinity meters), and a short US Coast Guard course in power

boat operation (including passing a boat operators licensing exam), I began work on my project. From the beginning, it was clear I was not merely assisting on someone else's project. This was my research and I was responsible for its success. When I collected data, organized data, or analyzed data, it was *my* data—the potential source of *my* contribution to knowledge. When mentors, technician, and fellow interns at the Field Station asked how *my* research was going or inquired if *my* project was showing any preliminary patterns, I had the distinct feeling that I owned my project.

Early in my project, I faced a challenge. Stripe bass were difficult to catch. Day after day, I succeeded in catching fish for other interns' projects, but my project species were elusive. One of my mentors contacted a local fisherman for advice. This expert had helped field station personnel with their projects from time to time. A few days later, while out on the bay with my mentor and several other interns trying our best to catch stripe bass, we received a radio call. "This is the guy", my mentor said. Shortly after the call, a boat approached from across the bay and pulled alongside our craft. The boatman pulled a young striper out of a bucket filled with more stripe bass. We transferred the fish to our boat, and my project was ready to begin. I had all the fish I needed for my study. I anesthetized each fish, implanted the transmitters, sutured the incisions, administered a post-surgery antibiotic, and released the fish into the bay shortly thereafter. I could start tracking the next morning.

Throughout the summer, seminars and workshops enriched the REU program. Interns participated in scientific discussions and made oral presentations of preliminary findings. Through direct involvement in such activities, interns developed skills that would contribute to their future success in whatever career they pursue. Adjunct to the research were cultural trips to nearby New York City and Philadelphia, a cruise on a US Coast Guard Research Vessel, mentor/intern kayak races, and impromptu midnight swimming parties.

The REU internship culminated with a formal presentation of a large laminated poster that, through text, photos, and graphics, portrayed the intern's research project. The poster conference was a well-attended affair at Rutgers. Along with the other interns, I stood next to my poster, like an artist in an uptown gallery, and answered questions as viewers studied my work. For me, this capstone event underscored the authenticity of the REU experience. This had not been a "classroom exercise." We had done real research and real researchers had attended this session to learn about our work. From proposal to presentation, the REU

program provided undergraduates with a condensed, but genuine research experience.

Goals and Benefits

The REU program gave interns a sense of the amount of talent and commitment required to succeed at a research career and offered them countless opportunities to evaluate their intellectual, psychological and physical commitment to such a future. At the field station, where projects were largely field oriented, research sometimes involved hard physical work, adverse conditions, and long hours. I usually woke early and worked late. Constant exposure to the elements resulted in a bronze, weathered appearance. Even on cloudy, sunless days, the reflection from the water intensified sun exposure. The nautical working conditions of my project demanded a certain degree of pluckiness. Being in a small boat on the rolling surface of a large body of water requires being at ease with motion. I learned to deal with greenheads, nasty insects whose bites were so severe they left painful, quarter-sized welts on the skin. On some days, the air seemed clogged with swarms of these vicious little bugs.

When a violent summer storm blew in from offshore making boat operation risky, valuable tracking time was lost. Such unexpected setbacks provided opportunities to organize my data. Each day at the field station presented some challenge to the interns' coping skills. More than once, we coped with the classic marine research setback: gear overboard. Fortunately, these incidents occurred in the relative shallow water of the boat basin. In each case, the equipment was retrieved, but not without delaying the day's schedule.

Once, when an intern had momentarily turned away from his work, a snatch and run seagull flew off with his transmitter-implanted shad. The bird took off over a mud flat, landing periodically—since the fish was too big to swallow and too heavy to carry far. The intern gave chase and eventually reclaimed his transmitter. Stories such as this were common and a key learning component of the field research experience.

A significant part of my learning experience at the field station involved informal interactions with graduate students. These associations gave me a sense for the demands of the graduate study that is prerequisite for a research career. On one occasion, interns attended the thesis defense of a Masters candidate and gained insights into an academic process rarely seen by undergraduates. I spoke with the candidate minutes before the session began. She was clearly nervous. Watching the defense proceedings, I realized she was expected to know

everything about her project. Her committee members left no stone unturned. I am glad I had the opportunity to witness this event. When I get to that point in my academic career, I think I will be less apprehensive about what to expect.

By the end of the summer, I had learned how to operate a powerboat on rough waters, and gained other nautical skills including how to tie specialized knots. I had developed surgical skills and mastered suturing techniques. I had also become familiar with the use of specialized research equipment—transmitters, mobile hydrophones, global positioning devices, salinity meters, and special software programs.

Reflections on the REU Experience

Beyond the intended goals and benefits (i.e. authentic research experience, guidance of an expert mentor, valuable collegial relationships) of the REU program, my research experience provided less apparent benefits as well. In most cases, these benefits underscored things I already knew, but now know in a more genuine way.

Paradigm Shift

The most profound of these benefits concerned my own perception of learning. My REU internship gave me the opportunity to *learn something new*, not in the sense of acquiring some established knowledge that was yet unknown to me, but in the sense of discovering an aspect of the natural world unfamiliar to all. I think I first realized this when members of the field station's research staff began inquiring about the results of my study. They asked "Are the sub-adults moving with the adults?" Or, "Are you seeing any patterns, is the population spatially age-segregated?" They seemed sincerely eager to know something new about the ecosystem they had been studying for years. They wanted one more piece of knowledge to add to their understanding. They expected my research to contribute that knowledge.

Practically everything I previously learned centered on the *content* of a discipline. It was the type of learning that had regularly required me to state a correct answer, but rarely asked me to frame a well-phrased question. Involvement with research seemed to stand this concept of learning on its head. Research was a process-oriented activity. Content was an important backdrop to be sure, but the *process* of research embraced questions, not answers. As a researcher, I learned from experience. Data analysis, for example, was new to me. How should I interpret all the information I was gathering about fish

movement, water temperature and salinity? What did the computer-generated graphs mean? How do I compare my data with that from previous studies on the movement of adult fish? I learned these and many other skills through direct trial and error experience. As the summer progressed, I experienced a shift away from answer-dominated *content learning* and toward question-centered *process learning*. in response to my involvement with research.

Palpable Learning

As a REU intern, I encountered a learning experience that was direct and concrete. Although my mentors and other researchers at the field station nurtured my understanding of estuarine ecology, the estuary, itself, was also my teacher. It engaged more of me than a lecture hall ever had. This was palpable instruction assimilated through my senses.

In classrooms, I had learned of the effects of human activity on the environment, and thought I grasped the problem. Last summer on the bay, I saw the carcass of a magnificent loggerhead turtle washed up on a sand bar with clear propeller wounds in its skull, and then I *knew* the problem. In textbooks I had read of fish that communicate with each other audibly and thought I understood the phenomena. While on a weekend snorkeling adventure with fellow interns, I experienced first-hand the sounds of fish communication, and then I *knew* the phenomena.

Community

Throughout the summer, I gained insight into how research programs function. I learned that research happens as the result of a team effort. The expertise of faculty, graduate students, technicians and clerical staff all made valuable contributions to the success of each intern's project. I observed that research is not a socially remote or intellectually isolated activity, but a cooperative and relational undertaking. This spirit of cooperation and interdependency was evident in the work of the interns, themselves. Out on the water, almost everything I did required the teamwork of my fellow fish trackers. While one of us drove the boat, another operated the global positioning system that guided us to the hundred or so tracking points. At each tracking point, as one of us lowered the mobile hydrophone into the water, another intern adjusted the gain on the radio receiver in response to signal reception. At each fish finding, as one of us worked the directional

Editor's Note: Mr. Clerkin is an undergraduate student matriculating to Cornell University this fall for his junior year. He is majoring in Environmental Biology and is still considering his career options in light of his REU experiences. In addition to the contact information presented at the beginning of his article, he can be reached at pw42@cornell.edu.

hydrophone, a boat mate recorded temperature and salinity readings. As we performed these tasks, we always relied on a vigilant boat operator to keep us from running aground on one of the many sandbars scattered throughout the bay. One fellow intern was tracking sand sharks. Some of her specimens exceeded three feet in length. Restraining these sharks during the anesthetizing procedure required the teamwork of many hands. These experiences reinforced my understanding of how essential a cohesive and cooperative research community is to my growth as a scientist.

Applied Philosophy

My REU experience steeped me in an intellectual climate committed to the belief that the best way to learn the truth of an idea is to test it empirically. *Doing* science means practicing a belief system, a philosophy. I spent the summer among practitioners of this philosophy we call *science*.

All summer long, in dozens of subtle ways, their thought orientation distinguished itself from the thought methods used by the non-scientific world at large. The qualities of suspended judgment and tolerance of uncertainty, and recognition of the tentative and probabilistic nature of knowledge were apparent not only in the research, but also in the social ambiance, the informal conversations, and the mealtime debates. All those lecture notes about Galileo, Mendel, Bacon and all the others seemed to come alive and take form in the collective thought orientation that infused my summer experience.

Applying for an REU Internship

Admission into a REU internship program is very competitive. Many REU sites receive hundreds of applications from highly qualified students, but are able to accept only about ten. The application process is a lot like applying to college, and requires grade transcripts, a personal essay, and letters of recommendation. There is no application fee, however. Applications are obtained from the participating REU sites, not the NSF; most can be found online. Application for summer REU internships are generally due around mid-February. To learn more about the REU student application process visit http://www.nsf.gov/crssprgm/reu/reu_search.cfm.

Editorial

Two features in the journal *Science* caught my eye recently. Both dealt with undergraduate science education. The first involved profiles of undergraduate science educators from around the world (*Science*, vol. 317, pp 63-81). The insight I gained by reading these is that some of the same concerns and experiences that I have been sharing (see the May *Bioscene*) are not unique to my situation or colleagues at similar institutions in the United States. I took some comfort in this.

However, the second feature challenged a long-held belief that a "physics-first" curriculum would enhance learning in undergraduate science courses. A series of surveys conducted by Sadler and Tai (2007), indicated that a "physics first" or a "chemistry first" curriculum in high school does not significantly enhance learning for prospective biology majors.

My high school experience involved a grades 9-12 sequence. Typically, students in ninth grade took a course called Earth Science, which was a survey of chemistry, geology, and meteorology. However, our school offered another course called Introductory Physical Science. My father insisted that I enroll in that because he felt that physics was the foundation upon which all other sciences are based. I do not recall much except that I played with an equal-arm balance a good bit of the time and attempted to juggle terms such as mass and friction. I took physics again my senior year and learned a bit more. I took my chemistry during summer school and the rest of my grade school science experience consisted of biology and anatomy and physiology.

My grades were not fantastic my first year in undergraduate biology and chemistry. I studied, but my heart and my brain were not in it a good bit of the time. Also, I had difficulty connecting the dots between the high school physics and biology courses and what I was trying to grasp in those courses. Upon taking college physics in my junior year, I started connecting the dots. I became a "physics first" believer. I have advocated a beginning high school science curriculum with physics for many years now. As always, Dad was right.

References

SADLER, P.M. AND R.H. TAI. 2007. The Two High-School Pillars Supporting College Science. *Science* 317: 457-458.

Or was he? The Sadler and Tai (2007) study indicated that taking high school courses in the concentration of interest had more of an impact on performance, as measured by course grade, in college science classes. This held across majors in biology, chemistry, and physics. So a radical reshuffling of high school science sequence might not be the best method for strengthening preparation for college science.

The study does not totally shatter my faith in Dad's judgment. He also insisted that mathematics through calculus was vital for performance in the sciences. My high school curriculum ended with pre-calculus. I did pretty well in these courses and was satisfied with the instruction I received. What success I had in my introductory science courses, could be traced back to my being able to carry out algebraic manipulations and having some trigonometric background. Students surveyed in the Sadler and Tai (2007) study that had mathematics through calculus in high school performed better in their science concentration of interest at the college level.

When I attend conferences and interact with colleagues, I always bring up the subject of mathematics and student quality. Despite my newfound doubts about a "physics-first" approach to high school science education, I still believe that a strong foundation in mathematics is essential for success in the sciences. Even if you cannot recall a single trigonometric identity, use of the calculus power rule, or even the quadratic formula, the type of thinking required by mathematical problem solving is vital throughout the sciences.

I'm not saying that this is a definitive study. In fact, I think there will be (and should be) further study and discussion of this issue. But it forced me to question some long-held beliefs and to think about curriculum reform in alternative ways. And isn't that what research in science teaching supposed to do?

Stephen S. Daggett
Bioscene Editor

VARIOUS AUTHORS. 2007. The World of Undergraduate Education. *Science* 317:63-81.

Call for Reviewers

We are continually looking for persons who are willing to review manuscripts for *Bioscene*. We need reviewers for a wide variety of subject areas. Reviewers should be willing to provide in depth reviews and detailed suggestions for authors concerning revisions necessary to improve their manuscript for possible publication. Reviewers should be willing to provide a rapid turn-around time for the manuscripts they review. If you are interested in reviewing for *Bioscene*, please send an email that includes your phone number, FAX number, and a list of the areas for which you are willing to review to: Stephen S. Daggett, *Bioscene* editor, at stephen.daggett@avila.edu.

Call for Applications -- John Carlock Award

This Award was established to encourage biologists in the early stages of their professional careers to become involved with and excited by the profession of biology teaching. To this end, the Award provides partial support

for graduate students in the field of Biology to attend the Fall Meeting of ACUBE.

Guidelines: The applicant must be actively pursuing graduate work in Biology. He/she must have the support of an active member of ACUBE. The Award will help defray the cost of attending the Fall meeting of ACUBE.

The recipient of the Award will receive a certificate or plaque that will be presented at the annual banquet; and

the Executive Secretary will provide the recipient with letters that might be useful in furthering her/his career in

teaching. The recipient is expected to submit a brief report on how he/she benefited by attendance at the meeting. This report will be published in *Bioscene*.

Application: Applications, in the form of a letter, can be submitted anytime during the year. The application letter should include a statement indicating how attendance at the ACUBE meeting will further her/his professional growth and be accompanied by a letter of recommendation from a member of ACUBE. Send application information to: Dr. William J. Brett, Department of Life Sciences, Indiana State University, Terre Haute, IN 47809; Phone: 812-237-2392; FAX: 812-237-4480; Email: lsbrett@scifac.indstate.edu.

ACUBE Standing Committees 2007

Membership: Wyatt Hoback, *University of Nebraska-Kearney*

Constitution: Margaret Waterman, *Southeast Missouri State University*

Nominations: Melissa A.F. Daggett, *Missouri Western State University*

Internet: Bobby Lee, *Western Kentucky Community and Technical College*

Awards: William Brett, *Indiana State University*

Resolutions: Marya Czech, *Lourdes College*



ACUBE 51st Annual Meeting

Loras College
Dubuque, IA
October 4-6, 2007

*Integrating Teaching and Research
in the
Biology Classroom*
Preliminary Program

Thursday, October 4th

3:00-5:00 PM	Pre-Conference Field Trip: Visit nationally known Dubuque Arboretum	Meet at registration Area – Alumni Student Center
3:00 - 5:00 PM	Steering Committee Meeting	Wahlert Education 124
6:00 - 8:00 PM	Registration and Reception <i>H'ors d'oerves</i>	Reg.: Alumni Student Center - Lobby Reception: Ballrooms C&D
8:00 - 9:00 PM	Opening Session Welcome to ACUBE: ACUBE President: Ethel Stanley, <i>Beloit College</i> Welcome to Loras College Greetings from the Conference Chairpersons Program Chair: Presley Martin, Hamline University Local Arrangements Chairs Tom Davis, Loras College OPENING PRESENTATION Reacting to the Past – The Trial of Darwin Dan Seims, Bemidji State University	Alumni Student Center Ballrooms C&D
9:15 - 10:15 PM	Steering Committee Meeting	Wahlert Education 124

Friday, October 5th

7:00 AM - 5:00 PM	Registration table (Register, pay dues, buy T shirts, etc.)	Lobby – Wahlert Education
7:15 - 8:20 AM	Hot Breakfast	Alumni Student Center Ballrooms C&D
7:30 - 10:30 AM	Field Trip: Visit an Ordovician Fossil bed in Graf, IA	Meet at Registration Area
9:00 AM - Noon and	SUSTAINING MEMBER EXHIBITS	Wahlert Education 101

2:00 - 5:00 PM

8:30- 10:00
AM

CONCURRENT WORKSHOP SESSION I

Part 1: Development of a new outcome –based curriculum in the University of Wisconsin-Platteville program; Beth Frieders, Jeff Huebschman, and Wayne Weber

Wahlert Education 143

Part 2: Integrating Research in Introductory Biology Courses in a New Curriculum; Jeff Huebschman, Beth Frieders and Kris Wright, *U. Wisc-Platteville*

The case study method: Using case studies to bring research into the biology classroom; Debra Meuler; *Cardinal Stritch University*

Wahlert Education 145

Bridging the Gap: Connecting the Scientific Literature with Learning and Research; Katherine O'Clair; *Arizona State University*

Wahlert Education 110

10:00 - 10:30
AM

POSTER SESSION I

Refreshments provided

Posters: Wahlert Education Lobby

Introducing Cross Discipline Research Projects in Upper Division Courses; Carol M. Maillet; *Brescia University*

Refreshments: Wahlert Education 101

Integrating the scholarship of teaching and research: a case study examining wild bird food preferences at Millikin University in Decatur, Illinois; David Horn and Stacey Shonkwileer; *Millikin University*

10:30 - 11:15
AM

CONCURRENT PAPER SESSION I

An Example of Integrating a Community Action - Service Learning [CASL] Project into an Introductory Microbiology Class; Christine Bezotte, *Elmira College*

Wahlert Education 143

Using Clickers in the Classroom: Demonstration and Discussion; McGraw-Hill representative

Wahlert Education 145

Demonstration of Lenovo Laptop computers for use in the classroom; Lenovo Representative

Wahlert Education 109

Teaching Evolution in Secular and Christian Educational Settings - Obstacles and Opportunities for Student Learning; Richard G. Colling; *Olivet Nazarene University*

Wahlert Education 110

11:30 - 12:30
PM

Luncheon and First Business Meeting

- *First and Final Call for Nominations!!*
- *Out of this World Teaching Idea contributions*

Alumni Student Center Ballrooms C&D

12:30 - 1:30

Luncheon Program

Alumni Student Center

PM	Pedagogy of the Future: A discussion of future trends in higher education from a publishers perspective Lead by representatives from McGraw Hill	Ballrooms C&D
1:30 - 4:00 PM	Field Trips: 1. Hike in Whitewater Canyon Park 2. Shopping in downtown Dubuque at Cablecar Square	Meet at Registration Area
1:45 - 3:15 PM	COMBINED SESSION I	
1:45 - 3:15 PM	Discussion of Biology Textbooks with representatives of Mcgraw-Hill	Wahlert Education 110
1:45 - 3:15 PM	Integrating Chemistry and Microbiology in a Single Course for Nursing and Health Science Students; Linda O. Michel, Farahnaz Movahed Zadeh ² , Farrokh Asadi ³ , Abour H. Cherif ¹ , Bob Aron, Dianne M. Jedlicka ¹ , Frank S. Burrows ⁴ ; ¹ DeVry University, ² University of Illinois at Chicago, ³ Harold Washington College, ⁴ Pearson Custom Publishing.	Wahlert Education 143
1:45 - 2:30 PM	A Freshman Laboratory Curriculum – Buh-bye cookbook and hello research!; Tara Maginnis; <i>St. Edward's University</i>	Wahlert Education 145
2:30 – 3:15 PM	Malleability of <i>Xenopus laevis</i> Tadpoles in Research-based Physiology Laboratories Involving Heavy Metals; Gregory M Grabowski; <i>University of Detroit Mercy</i>	Wahlert Education 145
4:00 - 7:00 PM	Trolley Ride and Mississippi River Boat Tour	The trolley will pick everyone up at the main entrance to the college at 4 pm, and transport us to the Ice Harbor, where the tour boat is docked. We will return by trolley at approximately 7 PM for dinner.
7:00 - 9:00 PM	Dinner and Second Business Meeting (two-minute speeches prior to dinner; balloting after dinner, new officers announced at end of presentation) The 2006 Out of this World Teaching Idea Award	Alumni Student Center Ballrooms C&D
8:00 – 9:00 PM	Dinner Program Keynote address: “Bringing Biology Back to Life at JMU” Professor Jon Monroe Department of Biology James Madison University	Alumni Student Center Ballrooms C&D

Saturday, October 6th

7:30 - 8:45 AM	Breakfast	Alumni Student Center Ballrooms C&D
7:45 - 8:45 AM	Bioscene Editorial Board Meeting	Wahlert Education 124
9:00 – 11:15 AM	SUSTAINING MEMBER EXHIBITS	Wahlert Education 101
9:00 - 9:45 AM	CONCURRENT PAPER SESSION II	
	A Biology Course for the Less-Than-Prepared Prospective Biology Major; Janice Bonner; <i>College of Notre Dame of Maryland</i>	Wahlert Education 143
	Microbiology in the News; Nighat P Kokan; <i>Cardinal Stritch University</i>	Wahlert Education 145
	Partnering with Biotechnology Companies to Promote Student Research Experiences; Richard G. Colling; <i>Olivet Nazarene University</i>	Wahlert Education 109
	Integration of zebrafish research projects in an upper level molecular biology course; Lisa Felzien; <i>Rockhurst University</i>	Wahlert Education 110
10:00-10:30 AM	POSTER SESSION II	Posters: Wahlert Education Lobby
	Refreshments provided	
	Posters from Session I available for review	Refreshments: Wahlert Education 101
10:30 – 11:15 AM	CONCURRENT PAPER SESSION III	
	Using Biotechnology Research to Teach Biology to Undergraduates; Kristy L. Halverson, Marcelle A. Seigel & Sharyn K. Freyermuth; <i>University of Missouri-Columbia</i>	Wahlert Education 143
	Tools from Archaea to Fireflies: a Research Based Laboratory Project for a Molecular Biology Course; Kate Marley; <i>Doane College</i>	Wahlert Education 145
	Engaging Student in Introductory Biology Courses through the use of Clickers; Glenna Temple; <i>Viterbo University</i>	Wahlert Education 109
	The Undergraduate Research Experience: Enriching Undergraduate Science Programs Through Student Research; Agnes M. Vanderpool and John Copeland; <i>Lincoln Memorial University</i>	Wahlert Education 110
11:15 AM - 12:15 PM	Luncheon and Third Business Meeting	Alumni Student Center Ballrooms C&D
12:30 – 1:30 PM	Steering Committee Meeting Includes newly elected members!	Wahlert Education 124

51st Annual ACUBE Meeting

Learning by Doing: The Integration of Research and Teaching in the Biology Classroom

Oct. 4 -6, 2007

Loras College, Dubuque, Iowa



Area Map, Campus Map and Driving Directions to Loras College available at:
www2.loras.edu/college/maps

Dubuque does have its own airport served by American Eagle only. Other regional airports include **Cedar Rapids**, 1 hour 20 minute drive from airport to Dubuque, **Moline**, also about one hour and 20 minute drive to Dubuque, **Madison, WI** a 2 hour drive to Dubuque, or **Rockford, IL**, a 2 hour drive to Dubuque

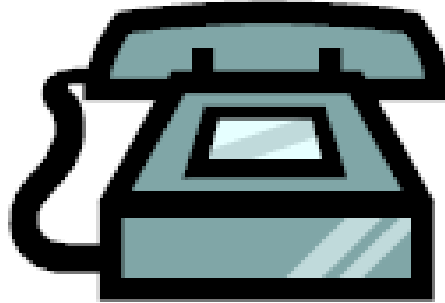
Housing Preview

51st Annual ACUBE Fall Meeting

Learning by Doing: The Integration of Research and Teaching in the Biology Classroom

**Loras College
Dubuque, Iowa**

October 4-6, 2007



Note: Lodging for ACUBE meeting in Dubuque; each hotel has a block of rooms set aside for our group for Thursday Oct. 4 and Friday Oct. 5, 2007.

Holiday Inn Five Flags – Downtown Dubuque

450 Main St.
563-556-2000
\$62 +tax per night

Ask for rooms held for Davis

Best Western Midway Hotel

3100 Dodge St.
563- 557-8000
\$65 +tax per night

**Ask for rooms for Loras College Biology
Teachers**

Reservations need to be made by Sept. 17, 2007

Hampton Inn

3434 Dodge St. (Hy 20 W)
563-690-2005
\$84 = tax per night

Ask for rooms held for Davis

Heartland Hotel

4025 Dodge St. Hy 20 W
563-582-3752
\$55 + tax per night

**Ask for rooms for Loras College Biology
Teachers**

Call for Resolutions

The Steering Committee of ACUBE requests that the membership submit resolutions for consideration at the 2007 Annual meeting to the Chair of the Resolutions Committee. Submit proposed resolutions to:

Sister Marya Czech, Dept. of Biology, Lourdes College, 6832 Convent Blvd. Sylvania, OH 43560,

Email: MCZECH@lourdes.edu

Phone: 419-824-3687

2007 Annual Meeting Registration Form

51st Annual Meeting

Loras College, Dubuque, IA

October 4-6 , 2007

NAME: _____ DATE: _____

DEPARTMENT: _____

INSTITUTION: _____

STREET ADDRESS: _____

CITY: _____ STATE: _____ ZIP CODE: _____

ADDRESS PREFERRED FOR MAILINGS: _____

CITY: _____ STATE: _____ ZIP CODE: _____

WORK PHONE: _____ FAX NUMBER: _____

HOME PHONE: _____ EMAIL ADDRESS: _____

Entire Conference Registration Fee: Includes all presentations, Thursday evening reception, meals Friday a.m. through Sat noon, refreshments at breaks, and most field trips. Circle the correct amount(s).

Membership status	By 9/15/07	After 9/15/07
Regular Member	\$100	\$115
Regular member + 2007 dues	\$130	\$145
New Member (includes 2007 dues)	\$130	\$145
Non-Member	\$130	\$145
Non-Participating guest/spouse	\$ 85	\$ 95
Student (Grad or Undergrad)	\$ 85	\$ 95
K-12 teacher	\$ 85	\$ 95
Friday evening dinner only	\$ 20	\$ 20

Field Trips and Workshop: Indicate all activities you plan to attend. Space is limited, register early!

- _____ 1. Thursday afternoon 3-5 PM: Visit nationally known Dubuque Arboretum, with Chinese garden, annuals and perennials
- _____ 2. Friday morning 8-10 am: Visit an Ordovician Fossil bed (~500 million yrs old) in Graf, IA.
- _____ 3. Friday afternoon 1:30 -4 pm: Hike through Upland Field, Forest and Limestone bluffs of Whitewater Canyon
- _____ 4. Friday afternoon 1:30-3:30 pm: Shopping in downtown Dubuque at Cablecar Square and Fenelon Place Elevator
- ___X___ Saturday Afternoon: National Mississippi River Museum and Aquarium -On your own. ACUBE members will receive a \$2 discount on Museum admission.

TOTAL ENCLOSED (Please make checks payable to ACUBE) _____
Sorry, checks or money orders only.

Special needs (food, facilities, etc.):

Optional: I would like to participate as a _____Mentor or _____Mentee.
(These participants will meet at the Friday breakfast.)

Please send registration form and payment to: Dr. Tom Davis
ACUBE Local Arrangements Chair
Department of Biology
Loras College
1450 Alta Vista
Dubuque, IA 52004-0178

Dr. Tom Davis
tom.davis@loras.edu
563-588-7767



Association of College and University Biology Educators

FIRST NAME: _____ INITIAL: _____ LAST NAME: _____ DATE: _____

TITLE: _____ DEPARTMENT: _____

INSTITUTION: _____

STREET ADDRESS: _____

CITY: _____ STATE: _____ ZIP CODE: _____ COUNTRY: _____

ADDRESS PREFERRED FOR MAILING: _____

CITY: _____ STATE _____ ZIP CODE: _____ :

WORK PHONE: _____ EXTENSION: _____ 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: _____

Would you prefer receiving the Bioscience Journal by Mail E-mail Website download

How did you find out about ACUBE? _____

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

DUES (Jan-Dec) Type of Membership _____

Mail this form to: ACUBE, c/o Tom Davis, Loras College, Biology Program, 1450 Alta Vista, Dubuque, IA 52004-0178. E-mail Address: tom.davis@loras.edu

Regular Membership \$30
Student Membership \$15
Retired Membership \$ 5

PAYMENT

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