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Cover Illustration (courtesy of Tim Mulkey, Indiana State University):  
Cobra Lily (Chrysamphora californica). These insectivorous plants are native to the mountains of northern California and Oregon coastal regions. Chrysamphora grows to about three feet high in its natural habitat. Insect prey enters the hollow leaves through an opening underneath the hood. The prey drowns in the fluid in the base of the pitcher. Nutrients from the prey are absorbed after bacterial decomposition of the prey.
Bioscene: Journal of College Biology Teaching

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WRITING ABOUT BIOLOGY:
HOW SHOULD WE MARK STUDENTS' ESSAYS?

Randy Moore
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Associate Dean, College of Science and Mathematics
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Many reports have concluded that today's students are poor writers. Most writing assignments have been mechanical and trivial (see discussion in Applebee 1981; Orlovensky 1991); for example, in most secondary schools and colleges only about 3% of assigned writing tasks require that students write more than one sentence (see discussion in Moore 1992b). Similarly, a recent survey of 95,000 high-school seniors found that 76% of the students could not write a persuasive letter, and 62% wrote unsatisfactory prose (see discussion in Moore 1992b). As European leaders consider requiring all secondary-school students to learn three languages, only 14% of U.S. eleventh-graders can write an adequate analytical piece in English (Sprout 1990). Consequently, U.S. employers must spend millions of dollars teaching their employees to write effectively. Because students know little about basic writing strategies (e.g., eighth-graders spend only 10 to 20 minutes per week learning how to write), we should not be surprised that college students cannot write well, much less use writing as a tool for learning (see discussions in Healy 1992; Landis 1991).

Many colleges and universities have implemented writing-across-the-curriculum (WAC) as a means of improving students' ability to write and learn. There are many considerations for effectively using writing in a science class to enhance learning (see discussion in Moore in press). Among the most influential of these considerations is the feedback given students when we mark the early drafts and, to a lesser extent, grade the final draft of a paper (Jewett 1991; see discussion in Moore 1992b). Indeed, one of the tenets of WAC is that students' writing, thinking, and understanding improve in response to guidance provided by teachers' marks and comments on early drafts of papers. These comments influence how students revise their papers and how they write, think, and learn about science. However, I contend that there is a bigger question that is seldom considered: do our marks and comments help students develop a writing style that will serve them well in their careers?

However, I contend that there is a bigger question that is seldom considered: do our marks and comments help students develop a writing style that will serve them well in their careers?

Most undergraduate science majors do not get jobs in fields closely related to their field of study (e.g., only 27% of biology majors get jobs in fields that are closely related to biology; see discussion in Graham and Cockriel 1990). Thus, our assignments and grading must help students write effectively, not just correctly, and must not merely reflect our biases regarding writing about a particular subject or discipline (see discussion in Moore 1992a). Are our assignments doing this? As scientists, are our sensitivities about writing similar to those of professionals in other fields? To answer these questions, we need to know 1) the errors that students make in their writing, 2) which of these errors are marked by teachers, and 3) the importance of these errors (i.e., how other professionals react to different kinds of errors in students' writings).
How Professors Mark Students' Essays

Connors and Lunsford (1988) studied 3,000 essays written by college students and graded by faculty from across the country. Their results, which are summarized in Table 1, documented 1) errors in writing, and 2) errors in writing that were marked by the instructor. Spelling errors, the most common mistake, are excluded from Table 1.

The most frequently occurring errors in students' writing involve punctuation (e.g., commas: 1, 3, 5, 8, 15, 17; apostrophes: 9, 20), verbs (6, 10, 13, 14), pronouns (2, 11, 16), diction (4), sentence boundaries (12, 18), prepositions (7), and modifiers (19). Five of the ten most frequent errors involve punctuation. Misuse of commas comprises three of the top ten stylistic errors, and half of the comma errors involve clause or sentence boundaries (e.g., lack of comma in a compound sentence or after an introductory element). Sentence or clause boundary errors (e.g., sentence fragments and run-on sentences) accounted for seven of the top 20 (and four of the top 10) stylistic errors. These results indicate that many students do not understand how to write a complete, much less an effective, sentence. Stressing how to write a complete, effective sentence when we grade students' papers will remedy many of the stylistic errors common in students' writing.

When teachers grade students' papers, the frequency of teachers' markings of errors does not correlate with the frequency of the error's occurrence (Table 1). For example, diction errors rank fourth in frequency of occurrence, but first in frequency of marking. Similarly, possessive apostrophe errors rank ninth in frequency of occurrence, but third in frequency of marking. Thus, although errors are common in students' writing, teachers do not always mark them. Moreover, teachers mark some errors more frequently than others. For example, teachers mark 62% of apostrophe errors, but only 29% of dangling modifiers and misplaced modifiers. This difference probably results from the ease of marking the error and the degree of annoyance of the error to the teacher. That is, apo-

<table>
<thead>
<tr>
<th>Table 1. How Professors Mark Students' Papers</th>
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<tr>
<td>Error or error pattern (ranked by percent of total errors)</td>
</tr>
<tr>
<td>-------------------------------------------------------------</td>
</tr>
<tr>
<td>1. No comma after introductory element 11.5</td>
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<tr>
<td>2. Vague pronoun reference</td>
</tr>
<tr>
<td>3. No comma in compound sentence</td>
</tr>
<tr>
<td>4. Wrong word</td>
</tr>
<tr>
<td>5. No comma in nonrestrictive element</td>
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<tr>
<td>6. Wrong/missing inflected endings</td>
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<tr>
<td>7. Wrong or missing preposition</td>
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<tr>
<td>8. Comma splice</td>
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<tr>
<td>9. Possessive apostrophe error</td>
</tr>
<tr>
<td>10. Tense shift</td>
</tr>
<tr>
<td>11. Unnecessary shift in person</td>
</tr>
<tr>
<td>12. Sentence fragment</td>
</tr>
<tr>
<td>13. Wrong tense or verb form</td>
</tr>
<tr>
<td>14. Subject-verb agreement</td>
</tr>
<tr>
<td>15. Lack of comma in series</td>
</tr>
<tr>
<td>16. Pronoun agreement error</td>
</tr>
<tr>
<td>17. Unnecessary comma with restrictive element</td>
</tr>
<tr>
<td>18. Run-on or fused sentence</td>
</tr>
<tr>
<td>19. Dangling or misplaced modifier</td>
</tr>
<tr>
<td>20. Its/It's error</td>
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</table>

* This is a condensation of Table 1 from Connors and Lunsford (1988).
 trophe errors are marked more often than are comma splices, incorrect verb tense, and sentence fragments not because these errors are considered to be more serious, but merely because they are easy to mark (Connors and Lunsford 1988). Interestingly, teachers mark only 43% of the most serious errors and only about two-thirds of the most frequently occurring errors in students’ papers (Table 1).

How Biologists Mark Students’ Essays

To determine if biologists mark students’ essays differently than do other teachers, I repeated the study of Connors and Lunsford (1988) using papers written by biology students. I collected papers from graduate students enrolled at Wright State University (Dayton, OH) and Baylor University (Waco, TX). Because these papers were written when the students were undergraduates at various colleges and universities throughout the country, I was able to randomly select a group of papers that minimized regional or institutional biases. I did not analyze papers that professors had not marked (these papers accounted for 42% of my 82-paper sample). I evaluated papers subjectively and with the help of Sensible Grammar, Correct Grammar, Grammatik Mac, Doug Clapp’s Word Tools, Mac-Proof, and Right Writer, all of which are “grammar checking” and “style checking” programs.

The results of my study are shown in Table 2. Not surprisingly, the frequency of errors reported by Connors and Lunsford (1988) was similar in papers written by students in undergraduate biology classes. Thus, students make the same errors when they write about biology as they do when they write about other subjects. However, biologists who grade students’ papers do not mark nearly as many of these errors as did the teachers evaluated by Connors and Lunsford (Table 2). This could reflect 1) an insensitivity to the errors, 2) a belief that marking the errors will not enhance learning, or 3) an inability to identify the error. Whatever the cause, biologists provide students with much less feedback about writing than do the professors included in the study of Connors and Lunsford (1988).

Many of the errors in students’ writing can be corrected without burdening students with grammatical explanations or contexts. For example, errors involving spelling and possessive apostrophes can be corrected with simple explanations (e.g., its vs. it’s) or a dictionary. Similarly, problems involving vague pronoun-reference and dangling modifiers can be corrected by insisting that students ask “What does this word or phrase refer to

Table 2. How Biologists Mark Students’ Papers

<table>
<thead>
<tr>
<th>Error or error pattern</th>
<th>Percent total errors (%)</th>
<th>Percent marked by teacher (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Vague pronoun reference</td>
<td>12.6</td>
<td>1.6</td>
</tr>
<tr>
<td>2. No comma after introductory element</td>
<td>10.4</td>
<td>1.2</td>
</tr>
<tr>
<td>3. No comma in restrictive element</td>
<td>8.3</td>
<td>1.8</td>
</tr>
<tr>
<td>4. Wrong word</td>
<td>6.9</td>
<td>6.4</td>
</tr>
<tr>
<td>5. Comma splice</td>
<td>5.8</td>
<td>2.0</td>
</tr>
<tr>
<td>6. No comma in compound sentence</td>
<td>5.8</td>
<td>1.3</td>
</tr>
<tr>
<td>7. Possessive apostrophe error</td>
<td>5.6</td>
<td>7.0</td>
</tr>
<tr>
<td>8. Wrong or missing preposition</td>
<td>5.3</td>
<td>3.1</td>
</tr>
<tr>
<td>9. Unnecessary shift in person</td>
<td>5.3</td>
<td>9.2</td>
</tr>
<tr>
<td>10. Wrong/missing inflected ending</td>
<td>4.9</td>
<td>2.6</td>
</tr>
<tr>
<td>11. Wrong tense or verb form</td>
<td>4.6</td>
<td>3.8</td>
</tr>
<tr>
<td>12. Tense shift</td>
<td>4.6</td>
<td>1.3</td>
</tr>
<tr>
<td>13. Lack of comma in series</td>
<td>3.7</td>
<td>2.0</td>
</tr>
<tr>
<td>14. Run-on or fused sentence</td>
<td>3.4</td>
<td>2.2</td>
</tr>
<tr>
<td>15. Pronoun agreement error</td>
<td>3.3</td>
<td>2.8</td>
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<td>16. Sentence fragment</td>
<td>3.3</td>
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</tr>
<tr>
<td>17. Dangling or misplaced modifier</td>
<td>2.4</td>
<td>1.2</td>
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<tr>
<td>18. Subject-verb agreement</td>
<td>2.3</td>
<td>3.2</td>
</tr>
<tr>
<td>19. Unnecessary comma with restrictive element</td>
<td>1.1</td>
<td>1.5</td>
</tr>
<tr>
<td>20. Its/It’s error</td>
<td>0.4</td>
<td>4.3</td>
</tr>
</tbody>
</table>
or describe?" Grammatic explanations are unnecessary to correct problems involving wrong words, wrong or missing prepositions, vague pronoun reference, unnecessary shift in person, and pronoun agreement errors.

Is Our Sensitivity to Errors in Writing Similar to That of the Public?

From Connors and Lunsford's (1988) data and my own in Table 2 I infer that professors grade students' essays in predictable ways: we consistently mark some kinds of errors, and tend to overlook other kinds of errors. However, these data do not reveal the seriousness of errors that faculty mark or ignore. Indeed, the comparatively high percentage of errors that we do not mark does not mean that these errors go unnoticed by others in influential positions.

Are the most frequently occurring errors the most serious errors? Are the most frequently marked errors the most serious errors? To answer these questions, Hairston (1981) sent a list of 65 sentences containing a variety of usage errors to more than 100 professionals, including 63 professionals in fields other than English teaching. These professionals, many of whom occupy influential, high management-positions, were asked to classify the errors in one of the following groups:

- status marking error
- very serious error
- serious error
- moderately serious error
- minor or unimportant error

The responses, which are summarized in Table 3, indicate that professionals recognize and often react strongly to several kinds of errors in writing. For example, professionals respond most strongly to "status marking" errors such as improper use of a verb (e.g., bring/brung: has went/ has gone), use of double negatives, and the use of objective-case pronouns as subjects. All of these errors are syntactic errors, as are those that elicit a "very serious" response: sentence fragments, run-on sentences, failure to capitalize proper nouns, nonparallelism, etc. (Table 3). Conversely, readers are not bothered by punctuation or semantic errors (e.g., among/between, data/datum. its/it's, unique/very unique).

Scientists can learn much from Hairston's study. For example:

*The sensitivity of professors to errors in writing differs significantly from that of influential people in other professions.

*Writing-errors that we call "superficial" are often important to people having the power to affect others' lives. Although teachers may mistakenly overlook "writing quality" in search of "content," the public does not.

*Rightly or wrongly, the professional public can be offended by apparently "minor" features of writing. If, as all writing instructors and writing books proclaim, writers should write with their audience in mind, we should stress to students not only the importance of avoiding the errors listed in Table 3, but also how to write effectively.

*Ineffective writing creates problems in and out of the classroom. We should inform students of the socioeconomic consequences of poor writing. If students do not understand the stylistic options available to them or the consequences of poor writing, then what they don't know will hurt them. When it comes to writing, ignorance is not bliss.

Noting these findings, Hairston (1981) concluded her study with this:

I was not surprised to have the comments indicate that the qualities in writing that business and professional people value most are clarity and economy. I was surprised, however, at how vehement and specific they were about misspellings, faulty punctuation, and what they un-abashedly call "errors." I think it is important for us and for our students to realize that this fairly representative sample of middle-aged and influential Americans has strongly conservative views about usage. Although there seem to be some signs of change, and on some usage items the public may be ahead of the professions, I
Table 3. Hairston’s (1981) Classification of Errors in Students’ Writing

Status Marking
- nonstandard verb forms in past or past participle: brung instead of brought; had went instead of had gone
- lack of subject-verb agreement: We was instead of We were; Jones don’t think it’s acceptable instead of Jones doesn’t think it’s acceptable
- double negatives
- objective pronoun as subject: Him and Richard were the last ones to leave the lab.

Very Serious
- sentence fragments
- run-on sentences
- noncapitalization of proper nouns
- would of instead of would have
- lack of subject-verb agreement (non-status marking)
- insertion of comma between the verb and its complement
- nonparallelism
- faulty adverb forms: He treats his students bad.
- use of transitive verb set for intransitive sit

Serious
- predication errors: The policy intimidates creativity in the lab.
- dangling modifiers
  - i as an objective pronoun
  - lack of commas to set off interrupters like however
  - lack of commas in a series
- tense switching
- use of a plural modifier with a singular noun: These kind of errors

Moderately Serious
- lack of possessive form before a gerund
- lack of commas to set off an appositive
- inappropriate use of quotation marks
- lack of subjunctive mood
- writing That is her across the street
- use of whoever instead of whomever
- use of the construction The situation is...when
- failure to distinguish between among and between
- comma splices

Minor or Unimportant
- use of a qualifier before unique: That is the most unique organism
- writing different than instead of different from
- use of a singular verb with data
- use of a colon after a linking verb: Three causes of hypertension are:
- omission of the apostrophe in the contraction it’s
think that we cannot afford to let students leave our classrooms thinking that surface features of discourse do not matter. They do.

To ignore Hairston’s study is to unnecessarily penalize our students by making their writing vulnerable to ridicule and negative reaction by people that the students seek most to impress.

Of What Value Are Our Comments on Students’ Papers?

Professors have traditionally written comments on students’ essays and term papers, assuming that students learn from such comments and that students will apply this knowledge to later writing assignments. Unless students have a chance to revise their papers, such comments have little effect on the quality of subsequent writing assignments. However, if students can revise their papers, students’ revisions in response to teachers’ comments can enhance learning and improve the quality of the students’ writing (see discussion in Doher 1991 and references therein).

Some professors go to great lengths when marking students’ essays. Interestingly, some of this work accomplishes little or nothing (Lees 1979). For example,

• There is no significant difference in the writing quality of students whose teachers mark all mistakes as compared to those whose teachers mark only a few of the mistakes (Arnold 1964).

• Writing an overwhelming number of comments on a paper does not improve a student’s writing (Harris 1978; Lamberg 1980). Few students read their papers start-to-finish when they revise their papers. Rather, they jump from comment to comment, making only the necessary “corrections.” Most students cannot respond effectively to more than about five marks per paper (Shuman 1979).

• Marks on final drafts of a paper have little effect on students’ learning or subsequent writing (Dudenhyer 1976; Beach 1979; Thompson 1981; Harris 1978).

For a more thorough discussion of how to mark students’ essays, see Moore (1992b).

Putting Research Into Practice: How We Should Mark Students’ Essays

The studies of Connors and Lunsford (1988) and Hairston (1981) and the data in Table 2 can help us appreciate 1) errors in students’ writing, 2) our sensitivity to those errors, and 3) the impact of those errors on professionals that students need most to impress. Many of the most serious errors described by Hairston (e.g., “status marking” and “very serious” errors, including use of double negatives, use of direct object as subject, and nonparallelism) do not appear in the Connors-Lunsford “top 20” list of errors. Similarly, many of the errors in the Connors-Lunsford “top 20” list are not viewed by professionals in other disciplines as “status marking” or “very serious.” However, some are. For example, use of the wrong verb form (sit/set) is a “status marking” error, while run-on sentences, sentence fragments, and lack of subject-verb agreement are “very serious” errors.

We can improve students’ writing by concentrating on the errors in Table 3 as we help students revise their papers. To be most effective, our instruction must include explanations of usage, semantic errors (i.e., word choice; e.g., sit/set), and syntactic errors (i.e., relationships between words; e.g., sentence fragments, subject-verb agreement). Connors and Lunsford (1988) and Hairston (1981) suggest that it would be foolish for us to concentrate on strict grammatical contexts such as infinitive phrases and nominative absolutes. Rather, we should concentrate on the writing strategies studied by Hairston (1981) that most affect other professionals’ views of our students’ writing.
Literature Cited


Acknowledgments

I thank Mike Swift, Nancy Stephens, and Jill Hammann for their help with this research and manuscript.
PLASMID TRANSFORMATION OF *Escherichia coli* WITH BIOLUMINESCENCE GENES

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Biology Department
The College of Saint Scholastica
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Duluth, MN 55811

Daniel J. Litwin
Saint Scholastica Student

Plasmid transformation of *Escherichia coli* can be easily performed within 20 minutes using a modification of the rapid colony transformation procedure (Hanahan, 1986; Smith and Danner, 1981). The lux genes, contained on the plasmid pLUX-Ap, provide a vivid demonstration of plasmid transformation by conferring on *E. coli* the phenotype of bioluminescence.

**Introduction**

There are numerous examples of organisms which demonstrate bioluminescence. These include bacteria, mollusks, worms, insects, fungi, jellyfish, and diatoms. Many marine organisms such as fish and cephalopods symbiose with bioluminescent bacteria and use the light for intraspecific communication. The enzymes involved in bioluminescence are known as luciferases.

The genes for bioluminescence (lux genes) have been cloned from a few marine bacteria (Shaw and Kado, 1986) and coleopterans (De Wet et al., 1985). The plasmid pLUX-Ap contains the lux gene system from a marine bacterium (*Vibrio*) and an ampicillin antibiotic resistance marker. The plasmid pLUX-Ap was constructed in this lab using the lux genes previously cloned by Shaw and Kado (1986).

The two major biochemical reactions for bacterial bioluminescence are:

1) $\text{RCHO + FMNH}_2 + \text{O}_2 \rightarrow \text{RCOOH + FMN + H}_2\text{O} + h\nu \ (490\text{nm})$
   
   (light rxn)

2) $\text{RCOOH + NADPH}_2 + \text{ATP} \rightarrow \text{RCHO} + \text{NADP} + \text{AMP} + \text{PP}_1$
   
   (Recycling rxn)

**Materials**

Colony transformation buffer (TFB), final pH 6.20 per liter:

- KCl (ultra pure) 7.4g (100mM)
- MnCl$_2$ · 4H$_2$O 8.9g (45mM)
- CaCl$_2$ · 2H$_2$O 1.5g (10mM)
- HAC0Cl$_3$ 0.8g (3mM) (hexamine cobalt chloride)
- K-MES 20ml of a 0.5M stock (pH 6.3)

---

10 Plasmid Transformation of *E. Coli* Walton and Litwin
Luria Broth (LB), final pH 7.5 per liter (Maniatis, Fritsch, and Sanbrook, 1992):

Yeast Extract  5g  
Tryptone       10g  
NaCl           10g  

LB petri plates: Add 15g agar/liter  
LBA petri plates: 50µg/ml ampicillin

E. coli strain TG-1 (JM109 and DH5α have also been used).


Crushed Ice and a Water bath at 37-42°C.

**Methods**

1. Take one or two colonies directly from an LB plate (which has been previously prepared within the last 72 hours) and suspend in 100µl of TFB. Add one µl of plasmid pLUX-Ap DNA (approximately 50ng) and incubate on ice for ten minutes. (A control is also set up at this point. The control consists of E. coli undergoing the same treatment except for the addition of plasmid DNA).

2. Place the bacteria in a 37 - 42°C water bath for 60 - 90 seconds. The timing here is critical and must not exceed 90 seconds. This procedure is referred to as “heat shocking”.

3. After heat shocking, place the bacteria on ice for two minutes.

4. Remove the bacteria from the ice and add 400µl LB. Plate directly onto the LB and LBA plates.

5. Allow the plates to dry and incubate overnight at 37°C.

6. Observe the colonies in a completely darkened room. Bioluminescence should become visible within two to five minutes.

**Results**

The untransformed E. coli (control) when compared to the transformed E. coli (both on the ampicillin containing plates) demonstrate that ampicillin prevents growth of all untransformed E. coli. This absence of growth in the presence of antibiotic demonstrates that E. coli does not contain endogenous ampicillin resistance. The growth of E. coli on plates without antibiotic demonstrates that the transformation treatment was not harmful to E. coli. Additionally, this plate demonstrates that E. coli is not bioluminescent. Colonies growing on the plates with ampicillin have the phenotypes of ampicillin resistance and bioluminescence.

A flask of LBA also provides a vivid example of the transformed E. coli’s bioluminescence. Inoculate the flask and grow for approximately ten hours. Observe in a dark room. Swirling the flask will enhance the bioluminescence (see the light reaction). If the bacteria have grown too long the media will have been depleted of nutrients and the bioluminescence will not be very visible. If this occurs, add more LB and observe after a period of ten to twenty minutes.
Literature Cited


Acknowledgement: We thank Dr. C. I. Kado for providing the lux genes.

First Call for Papers
AMCBT 1993 Convention

Millikin University, host of the 1993 AMCBT convention, invites all members of AMCBT to make plans to attend our annual fall meeting scheduled for October 28th through the 30th, 1993. Suggestions for papers, speakers, special topics or other items to be considered for the meeting agenda can be sent to any member of the steering committee or to Sister Jeanene Yackey, vice president in charge of the program. Harold Wilkinson is the local arrangements vice president. Please send your abstract and/or any suggestions concerning the meeting before February 1, 1993.

Abstract:

Send Abstracts/Suggestions to: Sister Jeanene Yackey, Fontbonne Science Academy, Fontbonne College, St. Louis, MO 63105-3098.
WHEN IN SCIENCE, DO AS THE SCIENTISTS DO: WRITING AND EVALUATING RESEARCH PROPOSALS IN AN UNDERGRADUATE GENETICS COURSE

MICHAEL J. SIMMONS

Department of Genetics and Cell Biology
250 BioScience Center
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1445 Gortner Avenue
St. Paul, MN 55108-1095

I describe an educational exercise in which the students in an undergraduate genetics class wrote short research proposals and then evaluated them in a process analogous to scientific peer review. The results of two independent runs of the exercise are described, including analyses of quality.

In 1990, after a sabbatical leave at a federal research institute, I returned to the University of Minnesota wondering how I might contribute more effectively to the education of my students. I wanted an activity that would engage them in the scientific process, that would emphasize logical development and critical thinking, and that would require written and oral communication. I also wanted something that would explore the ramifications of my lectures and lead the students beyond the textbook, acquainting them with original scientific literature. Total immersion in research during the previous year had suggested a strategy for achieving these goals. Why not have the students do exactly as scientists do? Let them find an idea and write a proposal to research it. Then they could turn a critical eye on each other and evaluate their work through peer review in the classroom.

I implemented this plan in my genetics course in 1990 and again in 1991. Each time there were about 100 students, mostly juniors and seniors majoring in biology, but also some beginning graduate students. I asked each student to write a short proposal designed to win a fellowship to conduct genetics research in an established laboratory. The sponsoring laboratory had to be specified on a cover sheet. Each proposal was limited to a few typed pages and consisted of three separate sections: Goals and Specific Objectives, Scientific Background and Rationale, Methodology and Research Plan. A bibliography was also required but it was limited to one page. A title and a 75 word summary were to be included on the cover sheet.

This assignment was announced on the first day of the ten week term and the finished proposals were collected at the end of the eighth week. Handouts distributed in the fourth week specified the proposal format and provided tips on how to find a topic and formulate goals. In 1991, a selection of proposals from 1990 was reserved in the library for students to peruse. I also held brief classroom discussions about proposal-writing strategies.

Each student submitted 11 copies of the proposal. I sorted these into packets and organized the class into peer review panels consisting of 10-12 members. Each member reviewed a packet of 10 proposals and wrote formal one-page critiques of two. At the end of the term the panels met for two hours to discuss and evaluate the proposals in their packets. As in professional grant reviewing, the panel members gave each proposal a score. We used a 10 point scale, with 9-10 being outstanding.
8-9 excellent, 7-8 superior, 6-7 very good, 5-6 good, 4-5 fair, 3-4 marginal and below 3 unsatisfactory. Either I or a teaching assistant also read the proposals and attended the panel meetings, but only as observers. We did, however, quietly assign scores to the proposals after hearing the group discussion. A student was designated to chair each panel. The discussion of a proposal was led by the students who were assigned to criticize it, but anyone could make comments. Students were rated for participation by me or the attending teaching assistant; we also read all critiques and rated them. Ratings of proposals were based equally on the average of the scores given by the panel members and on the score given by me or the teaching assistant. Ratings of participation, critiques and proposals were weighted 10%, 20% and 70%, respectively, to determine the final grade of each student. Scores, annotated proposals and critiques from peers were returned to the students at the time of the final exam.

What kind of proposals did the students write? Many concerned aspects of eukaryotic gene organization and expression, but there were also some about prokaryotic genetics, usually with a practical angle. In this era of genome mapping, it was not surprising to find that many students proposed to locate genes responsible for human diseases. Gene therapy was also a popular subject. Other topics included viruses, molecular evolution, chromosome structure, transposable elements, behavior genetics, protein structure, applications to agriculture, DNA replication, mutation and DNA repair. Many of these subjects had been treated only lightly, if at all, in the lectures in the course.

What about quality? In 1990, the instructor’s mean score for the proposals was 6.81; in 1991, it was 7.03. These compare to means on the midterm and final examinations of 6.26 and 6.67 in 1990 and 5.80 and 7.06 in 1991. The scores for the proposals were about as varied as the scores for the examinations, suggesting roughly the same distribution in quality. Correlation analyses support this view. The correlation coefficients for the scores on examinations and proposals were 0.22 and 0.32 in 1990 and 0.57 and 0.57 in 1991. For comparison, the correlations for the scores on the two examinations were 0.61 in 1990 and 0.71 in 1991.

A few proposals were beautifully developed, with clear goals, a cogent rationale, informative background and appropriate methods. Others were simply awful. However, most of the proposals were done reasonably well. As expected, graduate students outperformed undergraduates. The greatest weakness in the proposals was with methodology. Most beginning genetics students lack the technical know-how to propose feasible and effective methods. However, they do have interesting, even grand, ideas, perhaps because their minds have not yet been encrusted with technical details. In general, the proposals were put together well, with each section fulfilling its purpose, but there were grammatical and stylistic shortcomings.

How successful was peer evaluation? The panel discussions varied from mediocre to excellent. Some were positively thrilling. Each student was required to speak on a minimum of two proposals. Most spoke about many more. Sometimes the comments were trivial, pointing out typographical errors and grammatical flaws, but often they dealt with structure, logic, accuracy, significance, scientific merit and depth of understanding. The students showed remarkable sensitivity in making their criticism, realizing, I suspect, that fairness and a constructive approach are essential for the success of peer review. Objectivity in the review process was fostered by keeping both the authors and reviewers anonymous. In addition, no author was a member of a panel that reviewed his or her proposal.

For me, this whole activity was an experiment. I wanted to find out how students judge written material. One way of investigating this question is to compare the scores given by the students with the one’s given by me or the teaching assistants. The correlation coefficients were all strongly positive: 0.66, 0.81, 0.77, 0.71, and 0.78. This sug-
suggests that students are reasonably good judges of quality and that peer evaluation can be used to ease the instructor's burden of grading papers. As an aside, I should mention that after the panel discussions, many students spontaneously remarked how difficult it was to evaluate the proposals. Several also expressed sympathy for those of us who grade papers as stock in trade. More significantly, many remarked that after reviewing the proposals, they were in a position to write a much better one themselves. This suggests that much was learned in the peer review process. The students readily identified good elements to be emulated as well as bad ones to be avoided.

The students viewed this as a difficult assignment. Some were completely overwhelmed. Others found it stimulating, even exhilarating. They frequently described it as a challenge. Some were very uncomfortable moving beyond the certainty of the textbook. They struggled with the process of creating their own project. They complained of the stress but appreciated the freedom to think for themselves. A few oddballs even thought it was fun. The peer review panels were deemed very worthwhile, but a few students expressed reservations about being graded in this way. On balance, I think the activity was a big success, but I also think that it is better suited to more advanced courses with fewer students. Already instructors in some of the graduate courses in genetics, cell biology, and molecular biology at the University of Minnesota have tried it out with considerable success.

Did the activity have any intellectual significance? Obviously, every student learned about a particular topic—for example, the human fragile X chromosome, genes for nitrogen fixation in bacteria, RFLP analysis in maize—but they also learned about the process of scientific inquiry. This is Research with a capital R. Many people seem to think that research is groping around in the dark, 

\[\text{...many remarked that after reviewing the proposals, they were in a position to write a much better one themselves.}\]

a haphazard search for the strange and peculiar, governed mainly by luck. But most research I know has been done in rather strong light. It is systematic rather than random, and depends more on dogged perseverance than on simple good luck. The students who wrote proposals in my genetics course learned that Research requires a point of view. It begins with an idea that must be developed logically and carefully. Every effort must be made to articulate the point of view persuasively. Otherwise, funds to support the research will not be forthcoming. This is the world we, as scientists, live in, and I think our students need to be told about it.

What about the activity's educational significance? Few of my genetics students are likely to enter careers in which they will write or review research proposals. However, many will enter professions that will require persuasive, expository or critical writing. Some will have to compose impact statements, write job or product evaluations, or formulate clinical and research reports. Others will have to analyze these materials critically. In the cybernetic society of the future, everyone will need the skills to gather, assimilate, organize and evaluate information. People with the ability to articulate messages clearly, to specify objectives and formulate plans will have an advantage, with the greatest payoffs going to those who can translate their ideas into tangible outcomes. Educational activities like the one described here, with its emphasis on critical writing, speaking and thinking, are therefore not without practical significance. More importantly, however, such activities can engage a student in the creation of a realistic "product" from a carefully structured process. They can heighten the sense of individual responsibility for the activities in this process and allow for the feeling of definitive fulfillment that comes when the process is completed.
News & Views

SCIENCE EDUCATION AND CLASS SIZE

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International Falls, MN 56649

Why do we need science education?

In a democratic society, the strong support of the general public is needed in order to maintain a strong base in scientific research and science education. It is essential, therefore, to show the public why their support is important. Quality in education and skill in thinking are perceived to be in decline. The public’s current levels of scientific understanding are perceived to be inadequate for life in the 21st century. Continuing causes of general educational decline are routinely noted. Educational fixes are profligate. More of the three R’s are demanded. What should be done next (Hackerman 1992)?

Because 99% of the national population is not involved in science, nor do they want to be, it is in the scientists’ and science instructors’ best interest, as well as for the society as a whole, that we should put our best creative efforts into solving the problem of how to fan the interest of non-science majors in natural phenomena (Hackerman 1992). The science courses that are taught in community colleges will probably be the last formal education most students not majoring in science will take. Therefore, we should provide students with positive and quality scientific experiences. We should not further alienate them from science and from supporting science education and research.

This means current motivational forces applicable to science education must be modified to accommodate this pressing need instead of maintaining the status quo or making the problem of science illiteracy worse (AAAS 1989). It is important that such modifying actions are not at the expense of the non-science major students and science educators at community colleges.

Today’s average college student is virtually scientifically illiterate. Many of these students who enroll in science classes are at-risk and under represented students—that is they need more attention for learning to understand phenomena than science majors (AAAS 1989).

How should science be taught?

Science must fulfill an essential role as one of the liberal arts. The teaching of science to all college students must be imbued with a dynamic philosophy. The ideal science education revolves around students and teachers thinking together (AAAS 1990).

Science should be taught as science is practiced at its best and not as it is told about. When students are told about science, it is difficult for students to appreciate and understand scientific endeavors and science anxiety frequently develops (AAAS 1990).

As Fall (1992) points out, in ideal situations the students and teacher would act as a research team, generating ideas, setting up experimental designs, gathering and interpreting data, and writing up the final results. When they get involved in doing science they are more likely to retain their interest in science and be successful students and supporters of scientific programs.

Science educators should be developing higher-level cognitive skills where scientific con-
cepts and methodologies are used to analyze, synthesize, and evaluate problems (AAAS 1989; Raimondo et al. 1990).

Science should start with questions about nature, engage students actively, concentrate on the collection and use of evidence, insist on clear expression, use a team approach, and de-emphasize the memorization of technical vocabulary. Science should welcome curiosity, reward creativity, encourage the spirit of healthy questioning, avoid dogmatism, promote aesthetic response, and build on success (AAAS 1989; Litecky 1988).

Learning to think ensues from students investing time in thinking. To engage students in depth over their written and spoken products requires much instructor time and energy. Reading and analyzing student papers requires a great deal of instructor time and effort. These efforts can be accomplished and sustained when class sizes and teaching loads are not physically and pedagogically prohibitive (Holliday 1992).

When class sizes and teaching loads physically and psychologically are not overtaxing science teachers, they will give written tests and assignments. Work load will not drive the educational process. There will be no override on teaching quality. Instead of teaching students to memorize, thinking will prevail. We should teach students those things that are worth learning. We will not waste our energy, resources and students when we do these things. Teaching then becomes productive, in the long term more efficient, and enhances student learning (Holliday 1992).

One alternative idea to educational steerage instead of educational first class was suggested by E. F. Schumacher in his book on the economics, “Small is Beautiful: Economics as if People Mattered.” Schumacher essentially said that a philosophy of "smallness" is the reverse of current trends throughout society. Perhaps a similar "small" philosophy should guide educational practice.

Fall (1992) is convinced that in education, small philosophy guides us toward simplicity, streamlined infrastructure, student diversity, interconnected study, small schools—and, to go with our small schools, small classes. Small classes, of 15 students, mean teachers guide a family, rather than a mob, of students through a curriculum.

"Small" means teachers could more easily be guides, co-students, co-teachers, and co-inquirers with their charges. It means students learning to write because the teacher has time to read, critique, and offer suggestions to students to improve their writing. It means students learning to read because they have the unhurried time to enjoy the story and to cogitate on what it might feel like to one day have people read their own works. It means teachers enjoying teaching because they have the time and encouragement to create. It means small-school social problems, more of the kind that families experience rather than the kind that cities do.

Small education might be expensive initially, but the payoff in the long term could be an educated people that cares for their environment, reads with their children, writes to their representatives, votes wisely, and pays taxes rather then spends them (Fall 1992). The opposite to small education is what we have now—mediocrity or less than optimum learning environments. The alternative may lead to a much more enlightened society tomorrow.

Rationale for not increasing science class sizes

1. Today’s average college student is virtually scientifically illiterate. At-risk students often suffer from science anxiety and making classes larger continues to perpetuate their problems. When science class sizes are increased, there is a corresponding change in
teaching methods to accommodate the increase in teaching load. We should be reversing the trend of alienating students in science classes instead of increasing alienation.

2. **Teachers must recognize the economic compromises, but not compromises that are educationally damaging to our clientele—our students.** Frequently, attempts to increase science class sizes have been capricious, unilateral and not thoughtful. Local administrators need to take the lead when justifying recommendations for class size increases. Other factors besides state mandates for increased efficiency, staffing ratios and edicts of supervisory committees must be taken into consideration. Science faculty are unable to accept class size changes when the only reason for doing so is in the name of efficiency and economics. The burden of proof for justifying these increased class size changes should be on the proposers of the change.

3. **Some teachers of science have crushing teaching loads that make it nearly impossible for them to perform well, no matter how excellent their preparation may have been (AAAS 1989).** Some science teachers have normally taught at the maximum load and usually with the most number of preparations of any faculty over the past 25 years. We have spent needless hours putting up and taking down laboratory equipment that we could not leave out because we had to share lab space. Students have lost access to the laboratory and to the quality they deserved for the past 25 years. We have often spent hours in the labs without compensation in order to make programs go. We have provided field experience way outside of our required time without compensation in order to provide students with quality experiences. We have not asked to lower class sizes in major classes in order to maintain an effective student faculty ratio overall. We have compromised the times low enrollment classes are offered in order to offer more classes with higher enrollments. And now we are being asked to take on even more students which will further compound our load and quality problems.

4. **Teaching must provide more for students than listening to authoritarian presentations of scientific information.** When students are only told about science it is difficult for students to appreciate and understand scientific endeavors. When class sizes are increased in non-science majors classes we will not be able to effectively teach science as it is practiced. This further insures that our students at risk will get less attention.

Larger classes represent a movement toward more efficient production for an institution, but it will generally mean a reduction in the development of cognitive skills because teaching styles and behaviors will change as class sizes increase (Holliday 1992; Odden 1990; Raimondo et al. 1990).

5. **Extra teacher time, energy, and effort required with writing- and thinking-intensive courses can not be accomplished, yet alone sustained when class sizes and teaching loads are physically and pedagogically prohibitive.** Writing intensive classes are those defined where writing is the sole or major vehicle for student grading. If other courses with recognized lower class sizes and students at risk are allowed to exist, why are administrators interested in raising science class sizes where students without science backgrounds are definitely at risk in writing- and thinking-intensive classes? The learning process for students should be improved not denigrated. Our students do not deserve that type of education.

When class sizes and teaching loads physically and psychologically overtax science teachers they will be forced to go to non-writing tests and assignments. Work load then drives the educational processes which are not in the best interests of the students. There is usually a subsequent override on teaching quality. Instead of teaching students to think, memorization prevails. When memorization prevails we begin to teach students those things that are not worth teaching. We waste our energy, resources and students' potential when we do these things. It becomes counterproductive and in the long term less efficient and more damaging to stu
dents than we should allow (AAAS 1989, 1990; Holliday 1992; Litecky 1988; Raimondo et al. 1990).

6. Why do the students and the faculty have to take the brunt of higher class sizes in the name of economic efficiency when funding deferrals have gone to cover the cost of excessive administrative growth instead of keeping up with student growth? Colleges should achieve the desired learner outcomes, namely writing, computing, and thinking across the curriculum. These initiatives are not achieved by raising class sizes beyond that which is counter-productive (AAAS 1989, 1990).

7. The expansion of teacher work weeks to include night classes where more than two laboratory sections must be offered, may not be in the students' overall best interests. It is already very difficult to offer a lecture and laboratory experience over a five hour period during one night a week.

8. Increasing class sizes does not necessarily increase access for students. Offering a second section with a reasonable class size and with different times does. When students get the personal attention they deserve they will learn more. Putting more students into a class which drives the teacher to use less effective teaching, assessment, and guidance methods is hardly in the best interest of student access.

9. With many colleges finally seeing future development of remodeled laboratory facilities, science faculty and students will get to use those laboratories in a timely fashion without sharing inadequate and crowded rooms. Just when we get to a reasonable situation administrators have proposed larger class sizes that would perpetuate the problems of the past 25 years.

10. Class size increases should be concomitant with increases in funding for the science program and library and learning resources.

11. Will increases in class sizes be accommodated by contractual language and with the current staff? Does increasing class size mean that we will have to eliminate some offerings we currently have?

Literature Cited


Guidelines for Evaluating Undergraduate Education in Biology

Introduction

At the 1987 meeting of AMCBT a motion was adopted to develop a set of guidelines that could be used by the affiliate schools of the organization as an aid to help them establish acceptable programs in biology. After surveying member schools a set of guidelines were constructed using information from these surveys and model programs such as those used by the American Chemical Society. Following is the set of guidelines that came out of this effort. The intent of the organization is that they be used to encourage administrators to move in a positive direction towards improving their offerings in Biology.

In order to have an AMCBT Approved Biology Baccalaureate Program an institution should provide as a MINIMUM:

- 480 Hours of classroom work in biology (33 Sem. Hrs.)
- 360 Hours of Laboratory/Field work in biology (One 3 Hr. lab per week per semester)
- A core curriculum that covers the principles of prokaryotic biology, eukaryotic biology, evolutionary biology, genetics, cellular/molecular biology, ecological biology, physiological biology, anatomical biology.
- One year of advanced work in biology or allied fields that is outside of the core.
- One year of physics.
- Two years of chemistry to include general chemistry, organic chemistry and biochemistry.
- One year of mathematics and computer science.
- An undergraduate capstone experience such as research, internship or other appropriate activity.

In addition, in order to be acceptable to the organization, an approved program must meet acceptable standards of:

- Faculty size—composition (minimum four biologists, three-fourths of total to be full time with doctorates in Biology except for programs with a clinical component).
- Teaching loads (maximum 12 contact hours per week including lab).
- Support for Faculty Development.
- Library collection (minimum of 20 subscriptions to refereed journals, access to biological abstracts).
- Facilities and equipment to include animal-care protocol.
- Budget and administrative structure.

Each department should regularly review the curriculum to include provision for:

- Examinations, syllabi, and student research reports (oral or written)
- Textbooks
- Placement of graduates

Guidelines Rationale

Introduction

The principle purpose of having a set of guidelines approved by AMCBT is to help individual Biology departments provide biology majors with a sound education in the fundamental areas of modern biology. The best approach to doing this is to establish a broad set of guidelines that will allow departments to develop programs that will emphasize the strength of the institution and faculty.
An important factor in the design of a curriculum is the academic preparation and potential for entering students. Introductory courses should encourage and accommodate students with different backgrounds, potential and career goals.

**Total Hours**

No four year curriculum can cover the whole of Biology. The quality of the education is thus more important than the precise content. An approved program in Biology, exclusive of courses in chemistry, physics and mathematics, normally comprises about one-third of a total undergraduate program of 120 hours. It is therefore felt that a graduate in biology should have the following experiences as an undergraduate.

1. 480 hours in classroom work. Supervised reading courses, tutorials, active participation in seminars, and supervised self-study programs could also count.

2. 360 hours of laboratory work. These hours may be a combination of research and course combined laboratory, but no more than one fifth may be research-based. This is to insure a broad base of laboratory experiences.

**Laboratory Work**

Laboratory work should give students hands-on knowledge of biology and the self-confidence and competence to:

a. plan and execute experiments through the use of literature,

b. be logical, organized and critical,

c. perform accurate quantitative measurements,

d. develop skills of observation, recognition and classification,

e. communicate effectively through oral and written reports,

f. analyze data statistically and access reliability of results,

g. interpret experimental results and draw reasonable conclusions, and

h. develop hypotheses that can be tested using the scientific method.

**Core Curriculum**

Programs of study in biology for majors and non-majors can be organized in many ways to reflect the institution's mission, the available facilities, and the interests and capabilities of the students and faculty. However organized, the core curriculum must include experience in prokaryotic biology, eukaryotic biology, systematic biology, cellular biology, environmental biology, physiological biology, and anatomical biology. The identification of areas in biology that should be studies has been kept intentionally broad to allow approaches that cover the same material in different ways. This core subsequently provides the student with 21 semester hours (excluding co-requisite lab hours) of the basic principles and theory of biology.

**Advanced Courses**

In addition to the core program students in biology should take a minimum of six semester hours of advanced work. This allows the student to develop additional skills and knowledge to begin specializing in one of the many areas of biology.

**Supplemental Course Work**

A competent graduate in biology must have a solid foundation in the underlying skills and theory of mathematics, chemistry and physics. They are so intertwined with modern biology that it is difficult to find an area that is not affected by them in one way or another. Students should have a firm foundation in the fundamentals and application of mathematics; an understanding of the basic principles of linear algebra and practical knowledge of statistics. Experience with computers is highly recommended.
Research

It is recommended that a carefully designed program of distinctively problem-oriented undergraduate research be developed. It should be recognized, however, that independent projects make heavy demands on institutional resources and faculty and student time. **Proper supervision of research requires much attention by a faculty advisor, for which allowances should be made in teaching assignment.** Well planned research should help undergraduates acquire a spirit of inquiry, initiative, independence, sound judgment, patience, persistence, alertness and the ability to use biology literature.

Faculty

At least 75% of the teaching faculty should have earned doctoral degrees in biology or should have equivalent experience. Their scientific and educational capabilities should be distributed over the major areas of biology so that upper level and advanced courses are taught by faculty qualified in each specialty. **Faculty size and competence must be adequate to teach on a regular basis the full range of biology courses needed for undergraduate professional education. The number of part time faculty should be kept to a minimum.** Sound policies regarding salaries, teaching loads, promotion, sabbatical leaves and tenure are essential. This is needed to maintain high faculty morale.

Teaching loads are particularly important. Loads should be at a level to allow faculty to keep abreast of developments in biology and related disciplines. Teaching loads should thus be kept to no more than 12 contact hours per week (including laboratory supervision). Supervision of a student laboratory commits the time and energy of a faculty member as fully as the preparation for and presentation of a lecture. Also, part of the teaching load credit should be obtainable through guiding independent study and student research.

Facilities

The institution should have a library within or near the teaching building with holdings related to the size and nature of the biology program and research activities of staff and students. There should be a minimum of at least 20 current significant periodicals, with a significant back run, preferable 10 years, and a range of other reference material. In addition to primary sources, a significant secondary source such as Biological Abstracts ought to be available to teach students how to gain access to the biological literature. Access to computer terminals through which students may interact with bibliographic and data files is becoming increasingly desirable.

Laboratories should be well-lighted and ventilated and be equipped with such services as gas, water, and electric power. Hoods should be readily available and in working order. A chemistry laboratory standard established in California suggests 28 square feet and 42 square feet of working space per student for lower and upper division laboratories, respectively.

A resource room and self instruction center is strongly recommended. It could contain such things as those found in the traditional reading room. Newer resources such as videotapes, audio courses, calculators and computer terminals might be included.

Revised and adopted by members attending the 1992 meetings of AMCBT.
Election Results and Vitae of Representatives

DAVID FINLEY, PRESIDENT-ELECT 1992-1993

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                Lincoln University
                Jefferson City, Missouri  65101

EDUCATION
1962          B.S. Ed., Western Illinois University, Macomb, IL
1964          M.S., Western Illinois University, Macomb, IL
1967          Ph.D., University of Illinois, Urbana, IL

PROFESSIONAL EXPERIENCE
1964-65 (summer)  Instructor of Biology - Western Illinois University
1963-67          Teaching Assistant, Department of Botany - University of Illinois
1967-Present     Professor of Biology - Lincoln University
1986-Present     Head, Department of Natural Sciences and Mathematics - Lincoln University

COURSES TAUGHT
General Biology, General Botany, General Microbiology, Plant Morphology, Honors Botany,
Taxonomic Botany, Research in Biology, Seminar in Biology

COURSE DEVELOPMENT
Honors Biology, Plant Morphology

RESEARCH
Cytological studies on various species of fungi under grant from NIH (MBRS Program);
Survey of geofungi under grant from USDA (U.S. Forestry Service); Morphology and Cytology of
Pellicularia koleroga and Ceratobasidium flavescens (Ph.D. Research). Dutch Elm Disease
Survey funded by the City of Macomb, IL.

MEMBERSHIPS
Association of Midwest College Biology Teachers (Member of Steering Committee 1973-1976;
1988-1992; 2nd Vice President 1973-1974; Chairman of Constitution Committee 1975-1976;
Chairman of Nominations Committee 1976, 1988-1991; Member of Editorial Board 1985-present).
National Science Teachers Association; College Science Teachers Association.

HONORS/HONOR SOCIETIES:
H. D. Waggoner Distinguished Alumni Lecturer - 1969 - Western Illinois University; Member -
Sigma XI, Beta Beta Beta, Kappa Delta Pi, Pi Omega Pi, Chi Gamma Iota.

FELLOWSHIPS
University of Illinois Summer Teaching Fellowship - 1966

BARRBARA NEWMAN, Member at Large First of Three Years 1992-1995

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                Springfield, Missouri 65804-0094
                (417) 836-5300

EDUCATION:
1966          B.S. Ed., Southwest Missouri State University, Springfield, MO
1974          M. S. Ed., Southwest Missouri State University, Springfield, MO
PROFESSIONAL EXPERIENCE:
1966-1984 Laboratory Coordinator and Supervisor, Department of Biology
Southwest Missouri State University
1986-1992 Instructor with tenure, Department of Biomedical Sciences
Southwest Missouri State University

PROFESSIONAL HISTORY
I have twenty-six years of laboratory teaching experience in life science laboratories. These include general biology for elementary education and for non-majors, botany, zoology, genetics, human anatomy, human physiology, and concepts in Biomedical Sciences. I have played a major role in leading twenty-seven field trips to areas of Missouri, Arkansas, Tennessee, Florida, Texas, Arizona, and Mexico; have conducted numerous hands-on workshops for elementary and secondary school teachers; workshops for colleagues at meetings of the National Association for Biology Laboratory Education (ABLE), the regional Association of Midwestern College Biology Teachers (AMCBT), and the Missouri Academy of Sciences.

In 1982 I developed an 80-minute videotape, "Dissection of Muscles of Cat," and in 1984 a 120-minute videotape, "Dissection of the Cardiovascular System of the Cat." In 1986, I co-authored the laboratory manual Concepts in Biomedical Sciences (now being revised). Presently, I am developing a new non-traditional lab series for non-majors in biology.

For eighteen years I have served as a science resource person and presenter for the Springfield School System. In 1979, Dr. Wallace Weber and I organized the Iota Theta chapter of Beta Beta Beta. We served as sponsors 1979-1982. I was once again the faculty sponsor 1988-1991. I now serve as a co-sponsor for the College of Science and Math Student Advisory Council, co-director of Southwest District Missouri Academy of Science Junior Division and member of board of directors of ABLE.

My hobbies are my family, traveling and teaching biology (to any age group!!).  

ETHEL D. STANLEY, Member at Large First of Three Years 1992-1995

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EDUCATION:
1968-1971 Thiel College, Greenville, Pennsylvania; Biology Major
1973 B.S. Biology, Wayne State University, Detroit, Michigan
1976 M.S. Biology, Wayne State University, Detroit, Michigan
1989 Secondary Teaching Certificate, Millikin University, Decatur, Illinois
In Progress Ed.D. Curriculum and Instruction, Illinois State University, Bloomington, IL

PROFESSIONAL EXPERIENCE:
1970-1971 Undergraduate Lab Assistant, Thiel College, Greenville, PA
1972-1975 Graduate Lab Assistant, Wayne State University, Detroit, MI
1975-1978 Instructor, Oakland Community College, Detroit, MI
1988 Student Teaching, Warrensburg Middle School
1984-1988 Teaching Fellow, Millikin University, Decatur, IL
1988-present Visiting Instructor, Millikin University, Decatur, IL

PROFESSIONAL HISTORY:
I prefer to describe myself as an involved member of the Millikin Biology department who is also a graduate student at Illinois State University concentrating on educational technology in field studies. I have been involved in two successful grants this past year and remain an active member of the BioQUEST team. My background includes two publications in Bioscience, several presentations (NABT, AMCBT, and various local groups), and a role in the recent formation of an area middle-high school science teacher group.
Application For Membership
ASSOCIATION OF MIDWESTERN COLLEGE BIOLOGY TEACHERS

NAME:_______________________________ DATE:_________________

TITLE:____________________________________________________________________

DEPARTMENT:_______________________________________________________________

INSTITUTION:_______________________________________________________________

STREET ADDRESS:____________________________________________________________________

CITY:_________________________________________STATE:____________________

ZIP CODE:_________________________________________

ADDRESS PREFERRED FOR MAILING:__________________________________________

CITY:_________________________________________STATE:____________________

ZIP CODE:_________________________________________

WORK PHONE:_________________________ FAX NUMBER:____________________

HOME PHONE:_________________________ E-MAIL ADDRESS:____________________

MAJOR INTERESTS: _____________________________________________________________

( ) 1. Biology
( ) 2. Botany
( ) 3. Zoology
( ) 4. Microbiology
( ) 5. Pre-professional
( ) 6. Teacher Education
( ) 7. Other____________

SUB DISCIPLINES: _____________________________________________________________

( ) A. Ecology ( ) H. Molecular
( ) B. Evolution ( ) I. Development
( ) C. Physiology ( ) J. Cellular
( ) D. Anatomy ( ) K. Genetics
( ) E. History ( ) L. Ethology
( ) F. Philosophy ( ) M. Neuroscience
( ) G. Systematics ( ) N. Other____________

RESOURCE AREAS:
________________________________________________________________________
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RESEARCH AREAS:
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Have you been a member before?_________ If so, when?__________________________
PLEASE MAIL

MEMBERSHIP APPLICATION

FORMS TO:

Edward S. Kos
Executive Secretary, AMCBT
AMCBT Central Office
Department of Biology
Rockhusrt College
Kansas City, MO  64110

CURRENT DUES ARE $25.00