Promoting In-Class Student Involvement in Medicinal Chemistry[1]

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This paper describes a strategy intended to complement large-class medicinal chemistry instruction with the overall aim of focussing attention on student self-identity. Also reported are findings which appear to define a problem inherent in attempting to promote regular class attendance. Conduct of in-class review sessions, in which students hand in written responses to questions addressing comprehension of fundamentals, was modified to include questions about student interests and values. Uniformly high course/instructor assessment ratings with or without such student interest questions underscored the importance of the review process per se in showing concern for students. Using student oriented methods of instruction, a positive relationship between regular class attendance and exam performance has been observed. However, within groups of students with perfect and irregular attendance, wide variations in performance were noted. Amplification of this information to students during course orientation might obviate development of anecdote-based convictions, and result in a perception that regular attendance is generally necessary, but in and of itself is not sufficient for satisfactory performance.

INTRODUCTION

In the undergraduate semester curriculum recently implemented at this College, *Principles of Medicinal Chemistry I* was planned as a three credit course in the second professional year. This course emphasizes the relationship between chemical structures of drugs and their names (generic), mechanisms of action, biotransformation, and physical properties. Enrollment has ranged from 101-107 students.

Besides identifying, prioritizing and organizing subject matter for inclusion in the course, critical attention was directed toward selection of instructional methods. This process was guided primarily by my experience, which suggested that contemporary Georgia pharmacy students generally acquire a passive attitude toward medicinal chemistry instruction offered in the traditional lecture format. For many years, the lecture method seemed to be acceptable to most students in terms of course value and performance expectations.

However, too many students experience performance problems in medicinal chemistry courses, problems believed to arise from passivity, including inconsistent class attendance. Though easy to engage in at first, passivity quickly leads to erroneous mind-sets about the level of comprehension expected, which results in unsatisfactory

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Table I. Comparison of passive and active behavior on classroom activities

Activities	Passive attitude	Active attitude
Class preparation	unprepared	ready
Attendance	irregular	regular
Perceived role of the instructor	adversary, critic	guide, resource
Classroom behavior	passive	focussed
Self initiated course content review	inadequate	timely, regular
Awareness of required level of comprehension	low	high
Exam preparation	compressed, rushed	methodical, systematic
Exam performance	unsatisfactory	acceptable
Behavioral outcome	fear, anger, contrived deferral 1 (apple polishing), covert aggression, blame shifting	confidence, trust
"Corrective" measures	unproductive office visits	(none needed)

Table II. Examples of questions aimed at learning about student values, interests, and experiences

What's your hometown and what makes it special (or what is it known for)?
What are your plans for the Summer?
What's your favorite spot on campus?
What do you like to do for fun (hobbies)?
What will you be doing during Spring break (Christmas Holidays)?
Where do you live while in school?
What is the best kept secret in the College of Pharmacy?

midterm exam performance (Table I). This in turn leads to unacceptible and ineffective student behavior, such as engagement in argumentative, nitpicking dialog about specific exam questions, and open-ended complaints and laments aimed at creation or transfer of guilt. An approach to recovery taken by many students was to consult with me outside of class time about questions and problems with material to be covered on the next test. Though well-intentioned, this approach was judged to be marginally effective because it did not address central elements, summarized in Table I, critical for satisfactory performance.

Regardless of whether or not a student was able to define and correct performance problems in time to pass the course, the atmosphere of residual hostility, guilt and inferiority encountered in contacts with some of these students, after all was said and done, was unacceptable. And even more significantly, excessive passivity resulted in a very inefficient use of student (and faculty) time.

Thus student-oriented methods of instruction, focussed on stepwise identification of fundamental teaching points and their significance(1,2), were adapted for use in the course, *Principles of Medicinal Chemistry I.* Briefly, this approach requires students to prepare answers to fact-oriented study questions that address, in consecutive order, fundamentals covered in the reference source (the textbook chapter on a particular class of medicinal agents)[2]. Classroom coverage of each study question/answer is focussed on clear, concise amplification of the particular teaching point being addressed. Five to 10 study questions are generally covered per 50-minute class period[3]. The goal of this approach was to build and reinforce the student's perception of self-authority for satisfactory course performance. It is believed that efforts along these lines will nurture intrinsic achievement motivation(3,4). Although the course has only been given for two semesters, this approach has resulted in marked reduction in performance problems that I have often observed and experienced in earlier lecture-based medicinal chemistry undergraduate courses.

Conduct of regular review sessions was previously identified as a requirement for successful implementation of the above student-oriented approach(1). These sessions provided an opportunity to experiment with a strategy aimed at learning about the students as individuals. Reported below are findings concerning the impact of such efforts on student performance and course assessment.

It is generally believed by pharmacy faculty that students need to attend class regularly in order to make satisfactory progress. Indeed, many courses in this College have strict requirements which strongly discourage class absence.

However, it has always been difficult to convince a significant percentage of students that attendance is critical to success. An attempt was made to identify and characterize the basis for this conviction, using performance data from the Fall 1996 offering of the current course and from an earlier related course.

METHODS

The in-class review process vital to student-oriented instruction (1) provided a way of expressing instructor-initiated curiosity about the students as individuals and as a group. It also provided a method for taking roll. Thus, for 20-30 minutes of every third or fourth class period, each student prepared and handed in answers (on notebook paper) to a series of 3-5 review questions designed to reinforce fundamentals recently addressed in study questions. Responses to these questions were not graded, but response patterns were noted and covered during the next class period. Thus, review question responses had no direct bearing on a student's final grade.

On occasion, a question relating to the student as an individual was added to the Review Questions. Examples are given in Table II. Students were told: (*i*) that responses to such questions were voluntary, and (*ii*) my response to each of these questions. Sometimes, I would show them the particular question a class period or two early so they have some time to think over how or if they wanted to respond.

In an attempt to provide comparative data about the value of this exercise to the students, questions like those in Table II were omitted entirely from review sessions in the

[2]Sets of study questions for all textbook chapters to be covered during the semester are obtained by students before starting the course.

[3]For an example of the process, see the Appendix in reference 1.

Table III. Responses to selected questions aimed at "getting to know the students"[a]

Spring break plans	Percent	Summer activities	Percent	Campus home	Percent
internship	24.4	hosp./clinical pharmacy	22.2	(commute)	13.8
relax at home	28.9	retail pharmacy	47.2	residence hall	20.7
study	4.4	summer school	8.3	share apartment	39.1
vacation	22.2	other work	22.3	share house	17.2
work	20.0			sorority/fraternity	9.2

[a]Questions from which these responses were tabulated were presented to students in either *Principles of Medicinal Chemistry I* (Fall 1995) or *Introductory Medicinal Chemistry* (Winter 1995)

Table IV. Does "getting to know the students" affect course/instructor assessment?[a]

Term of course presentation:[a]	Fall 1995	Fall 1996
Questions in Table II presented?	Yes	No
Number of evaluations returned:	70	76
Evaluation Parameter[b]		
Fairness	4.79 (0.43)	4.91 (0.36)
Empathy	4.75 (0.57)	4.75 (0.63)
Motivation	4.47 (0.70)	4.57 (0.85)
Learning	4.55 (0.59)	4.74 (0.57)
Coherence	4.83 (0.36)	4.89 (0.35)
Organization	4.81 (0.43)	4.83 (0.41)

[a]In each of these courses, three 100 point midterm examinations were given prior to assessment. Cumulative class averages for all three midterms were as follows: Fall 1995, 272; Fall 1996, 279.

[b]Parameters were rated on a 1-5 scale (5=highest); each figure is the average score for that parameter. Standard deviations are reported in parentheses.

Fall 1996 offering of *Principles of Medicinal Chemistry I.* Then student response to six parameters associated with course quality was determined using the Course Evaluation procedure of this College. Briefly, students responded anonymously and voluntarily to questions which requested the student to rate the course/instructor on a scale of 1- 5 with regard to fairness, empathy, motivation, learning, coherence, and organization. Composite results were compared to those for the "complete" earlier offering of this course.

A comparison was made between class attendance and performance on the comprehensive final exam given to 101 students in *Principles of Medicinal Chemistry I,* Fall Semester 1996. This exam covered 32 class hours, during which nine review sessions were conducted at regular intervals. These sessions were not pre-scheduled, enabling attendance of each student to be "spot-checked" nine times. Student exam scores were grouped on the basis of the number of review sessions missed, and for each group, the average test score and range of scores was determined. A similar comparison was made in the Winter 1995 offering of *Introductory Medicinal Chemistry* involving the performance of 107 students on one of the midterm exams. This exam covered 16 class periods, including five review sessions at which attendance was checked.

RESULTS

Getting to Know the Students. Questions in Table II and related ones have been used in in-class review sessions for three offerings of *Introductory Medicinal Chemistry* (1993-95) and one of *Principles of Medicinal Chemistry I* (1995). The overall response rate to such questions has been in the range of 80-90 percent. Examples of composite responses to three of the questions in Table II are shown in Table III.

Student assessment results from the Fall 1995 offering of *Principles of Medicinal Chemistry*, in which questions like those in Table II were presented in review sessions, did not differ from those obtained from the Fall 1996 offering of this course in which such questions were omitted. There were no major differences in composite midterm exam averages between these two courses (see Table IV).

Does Attendance Affect Exam Performance? In *Principles of Medicinal Chemistry I,* final exam averages for subgroups of students with two or less absences during the semester were within five points of each other (Table V) and did not differ from the overall class average. On the other hand, the exam average for the subgroup with three or more absences was lower. In the subgroup of students with perfect attendance, 34 percent received A-grades and nine percent had borderline pass/fail grades on the final exam; respective percentages were 16 and 26 percent for the subgroup of students with three or more absences.

In *Introductory Medicinal Chemistry*, exam averages for subgroups with 0-2 absences were similar to each other and to the overall class average, but the exam average for the subgroup with three or more absences was significantly lower (Table V). Five of the 11 students in this subgroup did not achieve passing grades (70) on this exam. Of particular significance in each course was the wide range of scores within respective subgroups, inferred in standard deviations (SD) and expressed clearly in respective ranges of exam scores.

Systematic study of other factors besides attendance, which could affect exam performance, have not been carried out. These include overall demographic and aptitude differences of students in the two courses, and the fact that these courses were offered in different professional years. So, despite similarities in attendance/performance patterns, comparison of results for the two courses must be approached with caution.

DISCUSSION

In order to enable Georgia pharmacy undergraduates to pursue medicinal chemistry instruction with an active attitude (Table I), recent experience strongly indicated that in-class attention needed to be focussed away from the instructor and toward not just the content and significance of coverage, but in particular on the students themselves. Thus, a small but significant amount of class time was dedicated to examining issues, exemplified by sample questions in Table II and selected composite student responses in Table III, related to student self-worth and self-esteem. An earlier variation on this approach was suggested to enhance student motivation(5).

In general, the assessment data (Table IV) indicated a high level of student approval of instruction supplemented with regular review sessions in the courses in which it has

Table V. Effect of attendance on exam performance[a]

	Course							
	Introductory Med. Chemistry Winter 1995				Prin. of Med. Chemistry Fall 1996			
Number of review sessions missed	0	1	2	≥3	0	1	2	≥3
Number of students	44	35	17	11	42	26	14	19
Group average score	86.4	82.2	82.7	72.1[b]	86.2	87.1	89.3	82.0[b]
Group SD	10.8	10.2	11.1	10.3	8.6	8.5	5.2	9.2
Class average (SD)	83.0 (11.4)				86.1(8.6)			
Score range	**Percent of students[c]**							
96-100	11	11	6	0	17	15	14	5
91-95	30	6	17	9	17	19	36	11
86-90	23	29	24	0	31	38	29	32
81-85	11	11	17	9	12	0	14	16
76-80	11	14	18	9	14	15	7	11
71-75	5	11	6	9	2	8	0	5
66-70	2	9	6	36	5	0	0	16
61-65	5	6	0	18	0	4	0	5
56-60	0	3	0	0	2	0	0	0
51-55	0	0	0	9				
46-50	2	0	6	0				

[a]Examinations contained 40 (1995) and 50 (1996) objective (multiple choice and matching) questions.

[b]Significantly different from the overall class average at $P < 0.05$ (1995), $P < 0.10$ (1996).

[c]The number of students in each group within a particular score range divided by the total number of students in that group x 100%. Example: five out of 44 students (11%) who missed none of the review sessions in Introductory Medicinal Chemistry had midterm scores ranging from 96-100.

been implemented. Indeed, in earlier years when *Principles of Medicinal Chemistry* was taught in lecture and/or the present formats in which review sessions were omitted, evaluation ratings on items related to those specified in Table IV, and others, rarely averaged above 4.0 and typically ranged from 3.0-3.75. However, responses to the evaluation parameters for the Fall 1996 course, in which specific "student interest" questions were not presented, did not differ from those of the Fall 1995 course in which they were used. Also, undesirable and ineffective student behavior not subject to quantification was uniformly minimal during the conduct of these two courses. Thus, adversariality and manipulative tendencies, incidences during exam periods of "wandering eyes", attempted engagement in dialog about the mechanics of test questions during and after exams, and requests for remedial instruction were markedly reduced in relation to earlier years of the course.

Two factors could account for similarity of course/instructor evaluation results in *Principles of Medicinal Chemistry I.* Composite midterm exam averages were similar for these courses. It seems unlikely that students considered as a whole are capable of separating course performance from their assessment of course/instructor quality. But more significantly, even without the student interest questions, the service associated with the conduct of review sessions (using plenty of class time, thanking the students for turning in papers, handing the papers back in class sequentially in alphabetical order thus obviating the usual crush at the point of exchange otherwise associated with this), and presumably the improvement in exam performance perceived by students to arise from these sessions, could by themselves have conveyed to students an attitude of understanding and concern. The fact that responses to review questions are not graded, and thus have no direct impact on student performance, might relieve the pressure otherwise associated with this form of recitation and thus also have contributed to the perception of empathy.

Regular class attendance is a behavioral attribute suggestive of an active attitude toward learning. Yet, a small but significant number of students attend class rarely. There are several factors which could account for chronic nonattendance. Bad chemistry regarding interaction with the instructor, disinterest in the subject matter, and higher prioritization of out-of-class activities come to mind. Also, a perception that the material can be learned faster and better without coming to class would lead to nonattendance.

Attempts at improving attendance through enforcement of rules, and application of instructional technology in such enforcement, have been widely used(6,7). Strategies include administration of pop quizzes and implementation of assigned seating. In addition, incentives such as giving extra points for perfect attendance can be offered. Although these approaches will ensure high attendance, they severely undermine the overall goal, highlighted in the Introduction, which has guided the development of *Principles of Medicinal Chemistry 1.* Application of motivation strategies emerging from systematic identification of challenges associated with promotion of regular attendance appeared to stand the best chance of being effective(7). Accordingly, an alternate educational approach was judged to be consistent in developing student self reliance and active learning (Table I), and if communicated effectively to future incoming classes might lead to a change in student consciousness regarding the importance of regular class attendance.

Interpretation of the data in Table V is instructive in two ways with regard to the consequences of regular class attendance. The results suggest that a limited number of absences do not affect exam performance. However, when a nonattendance threshold (three recorded absences) is met or exceeded, reduced performance is seen. In a systematic study of lecture-based instruction in general chemistry, attendance was determined not to be a significant factor in

regard to exam performance(8). Thus, "student oriented" methods of instruction might have an advantage over traditional ones in promoting regular attendance.

Secondly, the wide performance variation within each attendance subgroup shown in Table V indicates that, in regard to exam performance, what is true for the particular subgroup as a whole is not true for each individual within that group. It is likely that this fallacy of composition is sensed by at least some of the students, resulting in emergence of a perception of the value of regular class attendance based largely on recounting of anecdotal experience. Thus, in a typically close-knit class of Pharmacy undergraduates, the news will quickly spread that "...two students who rarely came to class did well on the exam, but 3-4 other students who were there every day didn't pass!" (Table V: data for *Introductory Medicinal Chemistry*). From an educational perspective, a conclusion which could be presented to students viewing Table V is that although regular attendance is generally necessary, it is not by itself sufficient to assure satisfactory exam performance.

A future study will focus on whether other factors besides attendance could account for the performance differences indicated in Table V. For example, students with 3+ absences might have a significantly lower mean aptitude than that of the class as a whole. Thus, confirmation of current findings will be attempted using performance/attendance data from several subsequent offerings of *Principles of Medicinal Chemistry*, using the present method of checking attendance. This will be followed up by retrospective evaluation of the impact of other factors besides attendance on observed differences.

The kind of student interest questions exemplified in Table II would appear to be applicable in conjunction with large-class review sessions, regardless of the type(s) of instruction being used, in which an instructor desires not only to gain an understanding and appreciation of student identities, but also to change the pace of (lighten up) the normal routine. Such questions might be irrelevant in smaller lecture classes, or laboratory/practice settings of less than 20-25 students involving a single instructor over more than just a few class periods. It is speculated that conduct of such courses is less formalized, enabling greater freedom of interpersonal student-instructor interactions(9). Despite lack of documented improvement in performance or assessment, such questions are believed to be an important component in pre-empting performance problems, and thus they will continue to be presented regularly in *Principles of Medicinal Chemistry*. Future efforts will be directed toward presenting questions intended to identify patterns of diversity in values and interests among students.

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