

Articles

Dishonesty in the Biochemistry Classroom Laboratory

A SYNTHESIS OF CAUSES AND PREVENTION

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Although reports of academic cheating are abundant, there are relatively few papers in the literature that focus on cheating in the context of science courses and even fewer that address dishonest practices, such as “cooking” or fudging data, within the classroom laboratory. This paper briefly reviews the existing literature on academic dishonesty and explores two theories that can be used to explain why cheating occurs: (1) classroom goal structure and (2) attitudes of neutralization. We conclude with a discussion of the implications of these theories within the context of a biochemistry and molecular biology teaching laboratory.

Keywords: Academic dishonesty, cheating, inquiry-based labs, science writing heuristic.

Academic dishonesty is by no means a recent phenomenon; with each generation, there are those who claim that the situation is worse than before. Although this issue has been discussed in this journal [1], there is reason to believe that it is of sufficient concern to those involved in the training of future scientists, including biochemists and molecular biologists, that it deserves additional attention, particularly inasmuch as there might be a connection between academic dishonesty in the classroom laboratory and the much publicized issue of unethical practices in the research laboratory [2, 3].

This paper attempts to analyze some of the existing literature on cheating with a particular focus on the science classroom laboratory, the environment in which our future scientists receive most of their training. Although the review of the literature is by no means exhaustive, the points addressed lead to specific implications for the way the classroom laboratory course is taught that might curb some of the dishonest behavior that occurs.

CHEATING IN SCIENCE CLASSES

A search of the literature for studies that have focused on the issue of academic dishonesty would yield a seemingly endless list of papers. When one considers the number of students who take science courses, it is surprising to find that relatively few of these studies have specifically addressed cheating within the context of the science classroom, and studies of academic dishonesty in the laboratory classroom are even rarer. This is noteworthy because it has been suggested that cheating occurs more frequently in science, math, technology, and engineering classes than in any other discipline, with the possible

exception of business classes [4–7]. When one considers the concern that has been expressed in recent years about unethical practices in the life sciences and the possible connection between these unethical practices in the environment of the research laboratory and academic dishonesty in the instructional laboratory, the issue of academic dishonesty might take on particular relevance to those who teach biochemistry and molecular biology courses. Studies that specifically mention cheating in science classes fall into two categories: analyses of science classes from the perspective of all students, only some of whom may be taking science classes at that moment in time, and studies that focused on the perspective of only those students who are actually enrolled in science classes at the time the data were collected.

Surveys of All Students—Studies that focused on the entire student population were all based on self-reporting behavior surveys that were administered to students to measure the frequency of specific cheating behaviors [6, 8–11]. The questions in these surveys primarily focused on activities such as looking off another student’s exam paper or copying a homework assignment, but they also included one or two items that pertained to making up or falsifying data [6, 7, 10]. The frequency with which students reported participating in some form of data manipulation at least once during their academic careers ranged from a low of 8.6% [8] to a high of 48% [6]. These results can be compared with the range of 7% [6] to 49% [10] for self-reports of students’ obtaining information (in the form of either questions or answers) about an exam from a student who had already taken the exam. One study of self-reported cheating behavior and student beliefs toward this behavior specifically examined cheating within the context of a science class [9]. The authors do not list the specific items used on the self-reported survey, however.

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In their analysis of beliefs about cheating, they only refer to “science work,” not specific behaviors such as making up data or copying a laboratory report. The authors found that close to 80% of the students reported having cheated on their science work in the past. It is not clear, however, on which tasks within the category of science work students tend to cheat more regularly.

Surveys of Science Students—Several studies limited their survey instrument to items specific to the science classroom and limited the population surveyed to students enrolled in science classes [5, 12–14]. Even within the specifics of a science population and classroom, however, the survey questions were generalized and often excluded aspects specific to the laboratory. Lord and Chido [13], for example, administered a survey of cheating in science classes but treated “cheating” as a generic term and asked about copying or using “crib notes” on quizzes and exams; they never specifically addressed the laboratory component of science classes. Lord and Chido found that over 75% of the students surveyed had participated in some form of cheating behavior in their science classes, results that are consistent with studies of cheating in the general population of tertiary students. Singhal [14] included copying “homework or laboratory reports” and the plagiarism of a complete laboratory report within his survey of engineering students. Unfortunately, homework and laboratory reports were grouped into a single category, for which it was found that 62% of the students admitted to having copied. Only 13% of the students in this study, however, claimed that they had rewritten someone else’s report to turn in as their own. This might suggest that the copying of homework is much more common than the copying of laboratory reports, but it could also suggest that copying an entire laboratory report is viewed as much less acceptable than copying a few passages. McCabe’s [15] survey on cheating included the students’ academic major as a demographic variable. Results of this survey suggest that 57% of natural science majors and 64% of engineering majors reported that they had falsified laboratory data. These percentages were substantially higher than those for business, social science, or other majors, which should not be surprising due to the substantially larger numbers of laboratory courses in which science and engineering majors are enrolled. The most science-specific survey in the literature was administered in biology classes whose population included both biology majors and non-majors [11]. This study differed from others in the literature because it asked students what actions they *considered* to be academic misconduct, not those specifically in which they had participated. The prevalence of cheating was then measured by asking students whether they had ever engaged in misconduct, with 31% claiming they had. Interestingly, when it came to changing data or obtaining data from a skipped class, students in the lower level course that contained both majors and non-majors were more likely to believe that these behaviors were dishonest than the students in the upper level courses in which only biology majors were enrolled. The common factor in all of the studies cited so far is the fact that the primary focus of the survey was still on exams, quizzes, and assignments. Laboratory activities were added to the

survey almost as an afterthought, although the laboratory component of science classes is often considered their defining characteristic.

Studies of the Classroom Laboratory—It is only recently that the specific characteristics of a science classroom laboratory have been examined with respect to the type and prevalence of cheating behaviors that take place. Rigano and Ritchie [16] came across students’ “misbehaviors” while investigating the purpose of formal written reports in the laboratory. Using observations and interviews of nine high school students in science and engineering classes, they found that the students participated in four basic types of fudging behavior: making results fit the book, checking with classmates, excluding anomalous data, and making up or stealing results. Reasons students used to explain this behavior included time constraints within the classroom laboratory, inadequate equipment, already knowing the “correct” answer, and the requirement of a written report. This is further supported in a study by Mazzaro and Del Carlo [17], who found that the primary goal in laboratory for high school students was to get “the right answer.” Although many (45%) of the students opted to redo an experiment if the desired answer was not obtained, nearly 18% claimed they either copied another student’s results or fudged their data. Ritchie and Rigano [18] suggested reducing the total number of laboratories performed, using alternative forms of record keeping, such as reflective journals, instead of formal laboratory reports, and not grading on the basis of “accuracy” as ways to discourage the fudging of data but offer no theoretical support for their suggestions. In a study that supplements data collected on academic misconduct in the classroom laboratory, Syer and Shore [19] examined the amount of data fabrication or copying that occurred at science fairs. Surprisingly, 21% of the students admitted to making up either their data or their results. Students claimed that they did not receive or use sources of help for their project that they considered to be fair. In fact, of the students who admitted to making up their data, they all listed pressure for time as an obstacle to their participation in the science fair. Because the situation is one in which a final result is once again required for success, the science fair project in this case takes on the same personality as a traditional classroom laboratory exercise. Del Carlo and Bodner [20] explored the classroom laboratory at the college level within classes designed specifically for chemistry majors, a population of students who might hypothetically be more devoted to their science laboratories. They found that students were less concerned with *what* they were doing than with *why* it was being done. The goal of the classroom laboratory was often described as getting “good” data so that the students could perform their data analysis or write their report. Therefore, obtaining a set of data from another group when an instrument failed to work or changing an anomalous data point to improve the fit with expected results was simply part of the process of obtaining good data. These students clearly differentiated between an “academic” laboratory and the “real world” laboratories they would encounter in the future when they worked in a research or industrial setting. Whether it was quality assurance, water testing, or pharmaceutical effi-

cacy, they expressed the belief that the effect of data collected in research or industrial laboratories would reach far beyond the limited bounds of a classroom laboratory grade.

SITUATIONS CONDUCIVE TO CHEATING

Two prominent theories have been proposed to explain cheating within the context of a standard “non-science” classroom that can be used to understand the source of dishonest behaviors in the laboratory classroom. These theories revolve around the concepts of classroom goal structure and students’ attitude of neutralization.

Classroom Goal Structure—Anderman *et al.* [9, 21] were the first to use goal analysis of classroom climate, a theory based in social-cognitive psychology pertaining to student motivation [22–24], as a framework for understanding why students cheat. Goal analysis theory assumes that students have either performance-based goals or mastery/learning-based goals depending on their definition of what it means to be successful, the way they view the consequences of making mistakes, their motivation toward class work, and their perception of the classroom atmosphere. Success in a classroom environment that is oriented toward performance-based goals occurs when the student achieves or is awarded for a high grade relative to classmates [22]. There are a variety of ways of creating a classroom structure that stresses performance-based goals and results in an environment in which students are driven to compete with each other and in which mistakes elicit anxiety among students who make them. Students with mastery- or learning-based goals are primarily concerned with increasing their knowledge. A classroom supportive of mastery goals defines success not only by what the student knows but also the level of progress or improvement a student makes. Thus mistakes are considered a part of learning, and students are rewarded for correcting mistakes [22]. Grades in a mastery- or learning-based course are determined by an absolute or criterion-referenced scale rather than a bell curve, and rewards for improved academic gains are centered around mastery of the material. Although traditionally associated with models of students’ motivation for learning, goal theory has also been shown to explain the learning strategies of students whose goals are determined in part by classroom atmosphere. Anderman and Young [25] found that middle school students who possessed performance-based goals were more likely to use surface level learning strategies and less likely to use the “deep” cognitive strategies often necessary in the effective learning of science. They also noted that the goals possessed by students were strongly related to the types of teaching strategies utilized by their teachers. Instructors who used performance-based instructional practices were found to have students who used performance-based, surface level learning strategies. Generally speaking, performance-based factors, such as competition for grades, are perceived to be out of an individual’s control and are often cited as reasons for cheating [7, 14, 26]. Studies of middle and high school students indicate that cheating behavior, such as copying from others on homework and exams, is reported by more students in science and math classrooms that are highly

performance goal-oriented [9, 21]. Although Mazzaro and Del Carlo [17] did not explicitly measure specific classroom characteristics in their study, the survey responses they obtained clearly indicated that the students who participated in the study were in classrooms they viewed as performance-based. These students focused on getting the right answer, and consequently, copied others’ information to obtain it. In 1966, Rotter [27] devised a locus of control personality test that measured the extent to which individuals believe that their own actions determine the rewards they obtain. People with an internal locus of control believe that the rewards they obtain are determined by their own actions and behaviors, whereas those with an external locus of control believe that rewards in life are generally outside of their control. Students’ perception of locus of control within a classroom environment has been shown to contribute to their perception of “fairness.” The classroom goal structure model suggests that students who distrust their teachers and feel that they are being treated unfairly cheat because it is the only means they have of controlling their situation [28, 29]. Roth and McCabe [29] suggest overcoming this feeling of distrust with effective communication. It should be noted, however, that the structure of a mastery goal-based classroom, by definition, is one in which students are in control of their learning and outcomes. The work of Syer and Shore [19] is consistent with the classroom goal structure model. The structure of science fairs is inherently performance-based; awards go to the students with the “best” results, not necessarily those who have learned the most. The fact that most students reported that they did not receive the level of assistance in the execution of their project that they expected most likely also contributed to the feeling of being out of control of their project and may have led to the fabrication of data.

Attitude of Neutralization—The attitude of neutralization theory introduced by Sykes and Matza [30] was based within sociological deviance theory and was used to explain why delinquents who demonstrate a sense of guilt about their deviant behavior still repeatedly participate in this behavior. Sykes and Matza differentiated between rationalizations that occur *after* a deviant act has been carried out and neutralizations that occur *beforehand*. Neutralizations can deflect, in advance, social norms that should deter deviant behavior. When this happens, the act becomes justified; it might even be viewed as acceptable by that individual. As a result, it can be performed repeatedly despite its obvious contradiction to society’s definition of “right” and “wrong.”

The concept of neutralizing attitudes was first applied specifically to cheating on exams, quizzes, and homework assignments by Haines *et al.* [31] in 1986 and again in a follow-up study 10 years later [32]. Self-reporting surveys were used to determine the level of neutralization and the frequency of cheating among college students in both studies. Neutralizing attitudes of students were measured based on the level of agreement with statements such as “Jack should not be blamed for cheating if: 1. he doesn’t have time to study, 2. his cheating isn’t hurting anyone, or 3. the instructor left the room,” and then these results were correlated with students’ answers on self-reported cheat-

ing behaviors. Haines *et al.* [31] found that students with a high degree of neutralization were more likely to engage in cheating behavior. Across the 10-year time span, however, they noted that the overall level of neutralizing behavior decreased while more students admitted to participating in cheating, leading the authors to conclude that students are more aware of their cheating but might care about it less. Murdock *et al.* [33] have recently combined the factors of goal orientation and neutralizing attitude. Using student ratings of hypothetical vignettes, Murdock *et al.* [33], analyzed the three different context variables of teacher pedagogical skill, goal structure, and target of blame for cheating and correlated each to the acceptability and likelihood of cheating: in other words, the students' degree of neutralization. The authors found that the perception of students in performance-based classrooms was not a significant predictor of cheating when the teacher illustrated poor pedagogical skill (such as failing to appear prepared for classes and knowing only one way to explain topics). When students judged the teacher as having poor pedagogical skills, both the perceived likelihood of cheating and the acceptability of cheating were uniformly high. Only when the teacher in the vignettes demonstrated good pedagogical skills was a performance-based classroom structure a significant predictor of cheating. In other words, cheating within any type of classroom structure became justifiable when the teacher was deemed less competent, in which case the blame for a lack of learning is placed on the teacher and students are able to justify otherwise inappropriate behavior.

IMPLICATIONS FOR THE CLASSROOM LABORATORY

Although it is still unclear just how much cheating, data "cooking," "trimming," and "fudging" actually happens in our instructional laboratories, the ideas evoked by the classroom goal structure and attitudes of neutralization theories have implications for specific pedagogical changes that can be made within the classroom laboratory to help prevent this behavior. First, the structure of laboratory courses should be examined with regard to how they fit with in the classroom goal structure. Standard "cookbook" laboratories that are constructed to have some predetermined right answer that students must obtain automatically establish a performance-oriented rather than a mastery-oriented goal structure. By removing the appearance of a right answer, students can focus on the learning process and not the final result. This perception of the right answer was well documented by Del Carlo and Bodner [20] and by Mazzaro *et al.* [17] and was mentioned as a specific cause for data fudging by Rigano and Ritchie [16]. Unfortunately, of the four classifications of laboratory instruction styles, expository, open inquiry, discovery/guided inquiry, and problem-based, only open inquiry has an outcome that is not predetermined [34, 35]. True open inquiry style laboratories use a student-generated procedure, and observations are inductively analyzed to derive at conclusions and chemical principles in much the same way as research is conducted. The call for open inquiry laboratories is consistent with the efforts of the National Science Foundation (NSF) and other funding agencies to bring authentic research experiences into the undergrad-

uate laboratory [36]. The trick, however, is to integrate these research-type experiences into the classroom. One method that has received attention is that of project-based laboratories [36–42]. Although the specific format and application is varied, the basic premise is to integrate long term, student-guided, novel projects into the laboratory curriculum. Students are responsible for every aspect of the project, sometimes even including the acquisition of materials and equipment, giving students a feeling of ownership over their project. Projects can be as simple or as complicated as the class requires and are usually guided by a broad topic such as protein purification [39] or a specific but equally broad question such as "Is our global climate changing?" [41]. Two of the classes studied in Del Carlo and Bodner [20] implemented mini-projects within the curriculum. When students were asked about fudging their data for these projects, students felt that cheating on these projects was equal to cheating themselves since they had put so much work into them to begin with. Students felt that the projects were more "real," and they were genuinely concerned with understanding their project and troubleshooting problems, not just getting the answers. Considering the ease of implementation of expository or traditional cookbook laboratories, it is understandable that instructors are reluctant to give them up for more time-intensive research style projects. Perhaps the laboratories themselves would become less performance-oriented if the assessment of our students were changed. Popular forms of assessment of student performance in laboratories have been in the form of either a formal laboratory report or a worksheet with the students' calculations written out. Both styles match the cookbook nature of expository investigation, and neither have been shown to be effective in the construction of student knowledge [43, 44]. Alternative assessment strategies are less centered on the results obtained and instead are more concerned with the processes that a student followed [45], a style that more closely parallels a mastery-oriented classroom. One particular form of assessment slowly gaining in popularity is the science writing heuristic (SWH)¹ [46–48]. Instead of using the standard categories of purpose, procedure, data, calculations, and conclusions to guide student reports, the SWH poses a series of questions to students such as "What are my questions?", "What did I do?", "What did I see?", "What can I claim?", "How do I know (this claim)?", "How do my ideas compare with other ideas?", and "How have my ideas changed?" Although originally designed to complement true inquiry-style laboratories, Rudd *et al.* [47, 48] used it as a first step for transitioning from expository to inquiry-based laboratories and found that students' written explanations, use of symbolic notation, and exam performance all improved after using the SWH despite having used an expository style laboratory. This indicates that it is not so much the style of the laboratory that affects student learning and behavior as the form of assessment. Another issue that needs to be addressed is the neutralizing attitudes of students. Although it has been shown that a mastery-oriented classroom reduces the amount of neutralization by students

¹ The abbreviation used is: SWH, science writing heuristic.

[33], we as educators must bear some of the responsibility as well and start to assess our pedagogical practices. Although we do not propose that there exists one right pedagogy that all instructors should implement, we do advocate developing a reflective practitioner approach to teaching [49]. Truly insightful and organized educators know how their students are learning and what practices work best for both the educator and the student. We must remember that as educators, we set the example for our future biochemists, molecular biologists, and scientists who pass through our classroom laboratories.

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