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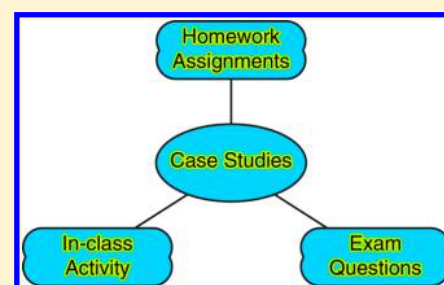
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## S Supporting Information

**ABSTRACT:** Case study exercises in an introductory biochemistry course can be used to help students master the content of the course while at the same time help build critical-thinking and problem-solving skills. Case studies can be used in a variety of forms: (i) as in-class group activities to either augment or replace content covered in lecture, (ii) as homework assignments, completed either individually or in groups, to assess mastery of content, and (iii) as exam questions to assess the students' ability to apply their biochemistry knowledge to a larger context and to discourage rote memorization. Scientific journals as well as articles in the popular press provide rich sources of case study material. A "directed" case study approach allows the instructor to focus student attention on the key content areas that the instructor wishes to cover, doing so in a manner that is interesting and engaging to the students.

**KEYWORDS:** Upper-Division Undergraduate, Biochemistry, Curriculum, Collaborative/Cooperative Learning, Student-Centered Learning



The "directed" case study method (first described by Cliff and Wright<sup>1</sup>) is used as a vehicle to convey content that might otherwise be covered in a lecture format. Directed case study analysis is more focused than an open-ended case study exercise and involves the introduction of the case by the instructor, who then poses a series of specific questions designed to concentrate student attention on certain key issues of the topic. In this manner, the instructor can cover the same scientific content as the lecture, while at the same time, increasing student interest so that concepts are mastered with a greater depth of understanding. Students hone their analytical skills by interpreting graphs and tables and critiquing experimental design in published journal articles. I have used directed case studies in an introductory biochemistry course in several ways: (i) as in-class group activities to either augment or replace content covered in lecture, (ii) as homework assignments, completed either individually or in groups, to assess mastery of content, and (iii) as exam questions to assess the students' ability to apply their biochemistry knowledge to a larger context and to discourage rote memorization.

Case study analysis is aligned with the philosophy of "social constructivism". Constructivism is the idea that knowledge is constructed in the mind of the learner, by the learner. Social constructivism adds another layer to this concept; that is, constructivism is enhanced when learning takes place in a social context. When students are engaged in case study analysis in their groups, they are constructing their own knowledge. Knowledge constructed in this way is far likelier to be retained than information delivered by an instructor's lecture.

## ■ CASE STUDIES AS HOMEWORK ASSIGNMENTS

I use case studies for homework assignments to discourage students from rote-memorizing the numerous metabolic pathways that are de rigueur for any introductory biochemistry course. Assignments are modeled on exercises used in medical schools. The cases feature patients with an "inborn error of metabolism" in which an enzyme that catalyzes a reaction in a metabolic pathway is mutated and no longer functional. To solve these cases, students use the patient's symptoms to identify the missing enzyme and to explain why the lack of the enzyme results in the observed symptoms. Mastery of these types of cases requires an in-depth knowledge of the major cellular metabolic pathways, but using the case as a vehicle to teach the pathways heightens student interest. These clinical cases are a powerful way to demonstrate the interconnectedness of metabolic pathways and to show the students the relevance of biochemistry to the medical field.

## ■ CASE STUDIES AS IN-CLASS CASE ACTIVITIES

Students solve case studies in teams of three or four during class. These case studies are short "stand alone" activities that fit easily into a single class period and are usually derived from peer-reviewed published scientific papers. As I circulate throughout the room, posing questions to the students and answering the questions they ask, I get a much better sense of how well the students understand the material, which I do not get while I am lecturing. Sometimes misconceptions, learned either in this class or in previous classes, come up, which I can address and hopefully dispel. During a case study exercise, the

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student teams answer the questions posed in the case and, in doing so, learn to communicate so that all of the students understand the material. At the end of the semester, the students show improved verbal and oral communication skills and greater comfort with the complex material.

### ■ CASE STUDIES AS EXAMS

As I began to incorporate more case studies and other group activities into my course, I realized that the traditional manner of assessment no longer seemed applicable. Grades are the currency among the students, and earning top marks is a powerful motivator. I realized that if I wanted to communicate to the students that I valued case study analysis, I needed demonstrate this by having the students solve cases on exams. The cases for exams are similar to those used in class and are based on peer-reviewed scientific journal articles. I usually post the background material for the exam case about 24 h prior to the exam, and I have learned to be circumspect when writing this material so as to not provide specific search terms for the students that would enable them to locate the original paper. The students are not provided with the questions ahead of time and are required to complete the exam working individually. Exams are held in the evening to give students more time to complete the exam.

### ■ SUMMARY

This paper was discussed from May 20, 2011 to May 26, 2011 during the spring 2011 ConfChem online conference, *Case-Based Studies in Chemical Education*. ConfChem conferences are hosted by the ACS DivCHED Committee on Computers in Chemical Education (CCCE), are open to the public, and can be accessed at the CCCE Web site, <http://www.ccce.divched.org/>.

### ■ ASSOCIATED CONTENT

#### § Supporting Information

A more complete version of this communication. This material is available via the Internet at <http://pubs.acs.org>.

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#### Notes

The authors declare no competing financial interest.

### ■ REFERENCES

(1) Cliff, W. H.; Wright, A. W. Directed case study method for teaching human anatomy and physiology. *Adv. Physiol. Educ.* **1996**, *270*, 19–28.