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THE SUCCESSFUL USE OF CASE STUDIES IN NUTRITIONAL BIOCHEMISTRY

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ABSTRACT

The Department of Chemistry at Georgia Southern University provides foundation courses for nutrition majors in the Department of Health and Kinesiology. One foundation course is Nutritional Biochemistry – a one-semester course that focuses on the basic principles of biochemistry as they apply to human metabolic systems. The students gain familiarity with biological molecules such as proteins, fats, and carbohydrates, and they learn how the body metabolizes each of these molecules. Traditionally this course has been taught with a lecture-based format placing the students in a passive learning role. Recently, case studies have been incorporated as a supplement to these lectures allowing small student groups solve problems similar to the types of problems they will encounter in their chosen profession. This method motivates and engages students because they see relationships between complicated metabolic pathways and metabolic or nutritional disorders. The case study method has proved to be very successful in the Nutritional Biochemistry course at Georgia Southern University. The students were actively engaged in learning the material, and these exercises developed their analytical skills as well as writing skills.

Keywords: Biochemistry, Learning Aids, Nutrition

INTRODUCTION

The Department of Chemistry at Georgia Southern University (GSU) provides two foundation courses for nutrition majors in the Department of Health and Kinesiology, a General Organic and Biochemistry (CHEM 1140) followed by Nutritional Biochemistry (CHEM 2542). Nutritional Biochemistry is a one-semester course that focuses on the basic principles of biochemistry as they apply to human metabolic systems. The students gain familiarity with biological molecules such as proteins, fats, and carbohydrates, and they learn how the body metabolizes each of these molecules. In the past Nutritional Biochemistry has been taught in the traditional lecture/laboratory method. The students could recite many biochemical facts, draw the structures for many carbohydrates, amino acids, and fats as well as complicated metabolic pathways (including all the intermediates), but they often *could not* see a connection between these pathways and subsequent health problems. Making these types of connections is not just a problem at Georgia Southern University but has been acknowledged in other undergraduate biochemistry courses (1). Since it has been well documented that

case studies motivate students and allow them to make connections among many different concepts, case studies were incorporated into Nutritional Biochemistry as a supplement to traditional lectures (2).

The case study method has been used for years to teach law, business, and medicine with substantial success (1-4). In the past instructors of science have rarely used the case study method, but this fact has changed in the past two decades. Articles have been published in several journals in which instructors describe using case studies in general chemistry (5,6), environmental chemistry (7), molecular modeling and computational chemistry (8), biochemistry (9), and non-majors sciences courses (10). Cases are usually written as dilemmas that give a personal history of an individual, institution, or business faced with a problem that must be solved. The students must work through all the facts and analyze the problem. Then as a team they consider possible solutions. The goal of using the case study method is to teach students how the process of science works and the development of higher-order skills or learning while also teaching science content. This method holds great promise as a pedagogical technique for teaching science, especially for students who are "turned-off" by the traditional lecture format (5-10). Case studies humanize science while illustrating the scientific method. They develop students' skills in speaking, writing, and analytical thinking. Students learn by doing instead of listening to a lecture or reading a textbook (5-10). Case studies make the concepts encountered in the lecture and in the textbook relevant since most are centered on problems that students will face in their future profession (11). For this course, case studies were chosen that deal with metabolic disorders, diseases that are the result of poor nutrition, or diseases that can be managed by a dietary change in conjugation with or in lieu of drugs.

BENEFITS OF CASE STUDIES

Description of Assignment

After covering the basic structure of biological molecules and intermediary metabolism, students embark on one of two case studies they will complete in a given semester. The class is divided up into small groups of 3-5 students and each group is assigned a different patient although all patients possess a common metabolic disorder. Each case is divided into two sections. The initial portion of each case study is an information gathering exercise; reference articles and websites are provided with a list of questions that investigate the metabolic problem, which is the focus of the case, as well as diets, supplements, or drugs that claim to treat the conditions and requires approximately 15-20 minutes of class time. The second portion of the assignment includes a discussion of the background research and then each group is given a patient who is suffering from the same metabolic condition they have researched and requires approximately 50 minutes of class time.

Section I:

- Professor presents case to entire class.
- Students divided up into groups and discuss their plans for dividing up the background research.
- Students are given 3-5 days to complete their individual research and

each team member receives a grade based on the value of his or her research.

Section II:

- Discussion of background research involving entire class.
- Each student group receives their patient and a list of questions from the patient.
- Each student group must answer all of the patient's questions and formulate a nutritional plan as if they are a team of nutritionists the patient has contacted.
- To present their plan, each group writes a short paper (2-4 pages) in the form of a letter to the patient. Each team receives a grade for the paper and each member of the team receives the same grade.

EVALUATION

To evaluate the effectiveness of each case study, I presented students with a survey immediately after they completed each case. Surveys contained between 8-12 statements, and the students were asked whether they agreed, strongly agreed, disagreed, strongly disagreed, or were neutral to each statement as well as a section devoted to student comments.

Table I: Survey Response Results

	Strongly Agree	Agree	Disagree
My knowledge of the connection between nutrition and [specific metabolic disease] was increased by this activity.	85%	15%	
Our group was able to formulate a nutritional plan for our patient based on the information gathered earlier by our group.	70%	11%	19%
I would enjoy the opportunity to participate in another case study.	92%	8%	

Table II: Student Comments

I like the fact that we were able to apply what we have been learning in class to a "real life situation."
I liked the fact that it was a real life simulation. It made my group want to work harder because we were acting as if we were really [a group of] nutritionists.
The case study was fun and interesting! We learned by talking to each other.
Finding out information together seemed realistic.

To further evaluate the effectiveness of this method, exam scores were examined. During the 2001 Spring semester, the Nutritional Biochemistry course was composed of 20 students, and no case studies were utilized that involved metabolic pathways. In contrast, the 2002 spring semester Nutritional Biochemistry course was composed of 26 students, and two case studies were presented that focused on metabolism and the connections between several metabolic pathways. Initially, final exams scores were examined since this exam is comprehensive and cumulative, including all metabolic pathways. When an increase was noticed in the section where case studies focusing on metabolism were used, the regular exam that focused mostly on metabolic pathways and their connections was also examined.

Table III: Comparison of Exam Scores

	2001 Spring Class	2002 Spring Class
Final Exam Averages	71 \pm 2.31* %	76 \pm 2.16* %
Final Exam Score Range	46% - 95%	55% - 94%
Exam #4 Averages	77 \pm 2.31* %	80 \pm 2.61* %
Test #4 Score Range	48% - 98%	61% - 98%

* 95% Confidence Limit.

A small but noticeable increase in performance is shown in Table 1 for the 2002 Spring Class (the section in which case studies that focused on these topics were employed). Other exam scores were examined to determine if the 2002 Spring Class performed better overall than the 2001 Spring Class, and no correlation was noted. The final averages for both classes were within two percentage points of each other.

CASE STUDY SOURCES

Writing case studies for one's courses is rewarding but can be very time consuming. Fortunately there are several books and websites that provide excellent cases for all disciplines, including biochemistry and nutrition. These sources usually include a case, a case solution, teaching notes, and integration techniques. For certain courses, minor modifications of these case studies may improve teaching effectiveness and student learning. Some of the most popular books and web sites are noted below:

Books

Biochemistry: A Case-Orientated Approach (12)

Biochemistry: A Problems Approach (13)

Biochemical Reasoning (14)

Clinical Detective Stories: A Problem-Based Approach to Clinical Cases in Energy and Acid-Base Metabolism (15)

Learning Biochemistry: 100 New Case Oriented Problems (16)

Textbook of Biochemistru with Clinical Correlations (17)

Web Sites

National Center for Case Study Teaching in ScienceWeb (18)

ChemCases: Case-Study General Chemistry Curriculum Supplements (19)

University of Delaware PBL Clearinghouse (20)

The Clearinghouse for Decision Case Education: Agriculture, Food, Natural Resources and the Environment (21)

DISCUSSION

The incorporation of case studies into the Nutritional Biochemistry curriculum at Georgia Southern University gave students the opportunity to learn in a more active environment. They gained knowledge of metabolic diseases and were able to make connections between the diseases and the metabolic pathways discussed in class. By working with their peers to solve the problem of their patient, the student teams learned by doing, not by listening to a lecture and memorizing specific points or structures!

The most popular case study in this course focused on Type II Diabetes (22) and a wide range of treatment options such as the Atkin's Diet, the herbal supplement Ephedra, and the American Heart Association's diet accompanied by exercise. The basic metabolic pathways of glycolysis, fatty acid metabolism, amino acid metabolism, and the Krebs cycle were revisited, but also signal transduction and insulin's role in glucose metabolism. When discussing the Atkins's Diet, the process of ketosis was reinforced, and students realized why the patient might be at an increased risk for kidney disease by looking back at the metabolic pathways of fats and proteins. The difference between thermogenesis and ketosis became very clear while discussing Ephedra as well as the fact that natural does not necessarily mean "good for you".

Additionally, these exercises allowed students to be creative. Almost every student team established their own nutritional firm name and approximately one-third of the teams came up with their own firm logo and used it to create personalized letterhead on which they wrote their patient letter. All students were actively engaged in solving the patient's problem, even the students who typically did not do well in the course. The only major criticism of this method by the students on both the case study evaluations and the end of the semester evaluations was the value of the case studies as a percentage of their final grade. In the past the combination of both case studies contributed to about 8-10% of their grade for the course. Several student comments indicated that the "amount of time and effort required to complete these case studies should have been worth more points". In the future, I plan to have the two case studies worth the same as one test grade, approximately 15-18% of their final grade.

The case study method has proved to be very successful in Nutritional Biochemistry. Not only are students actively engaged in learning, but they are also able to sort through a vast amount of information and make connections between this material and problems they might encounter in their future careers. These case studies allow students to be creative while developing their analytical and critical thinking skills as well as their ability to write and communicate.

APPENDIX I

A Sample Case Study

Adapted from Rubin, L. and Herreid, C.F.

Morgan: A Case for Diabetes

<http://ublib.buffalo.edu/libraries/projects/cases/diabetes/diabetes1.html> (accessed July 1, 2003)

Heather: A Native American Woman with Diabetes

Heather, a 27 year old Native American woman, was obese and led a sedentary lifestyle. She had heard of diabetes because one fourth of her tribe had this disease, but Heather had no family history of diabetes, heart disease, or other serious conditions; she never imagined she was at any risk. In the past few months, she had been experiencing unusual thirst, dizziness, blurred vision, and an awkward feeling of numbness in her right foot. She finally visited her family doctor on the advice of her parents. She was concerned but never suspected what she would hear.

After running several tests, Heather's doctor entered the room and said, "I'm sorry, Morgan, but the tests I've conducted unfortunately reveal that you have Type 2 diabetes. Your symptoms are exactly like those we see in many Native Americans. I understand this news is devastating for you, but I want to clarify that Type 2 diabetes is easily controllable through exercise, good nutrition, and weight loss."

"You mean if I lose weight I'll be OK?"

"Yes. If you are careful, weight loss will help manage your disease, and exercise will also help your condition. Please schedule an appointment with our nutritionist, Dr. Navarro. Losing weight will be easier for you, in my opinion, with the guidance of a professional. Come back in one month for a checkup, OK?"

The next day, she spoke of her condition to her family and friends and explained how weight loss was supposed to be an effective treatment. Her close friend Savannah suggested the Atkins' Diet. She told Heather the diet was fabulous because she could eat steak, chicken wings, and all the good stuff you enjoy and still lose weight.

"I don't know," said Morgan's brother, Alan. "There's a lot of argument about the Atkins' Diet. I think the best thing for you to do is exercise and stop eating all of junk food and sitting around the house."

Morgan sat silently, listening to the family debate and getting more confused. Finally, she asked her grandfather his opinion. He said nothing for a long moment and then, "Morgan, I think you should look to traditional herbal remedies for help. What Alan says is true. Exercise is good. But it is sometimes not enough. Our people have always looked to the natural medicine for cures. They will lift your spirits and energize you. Then you will lose weight and you will be healthy again."

"Do you mean I should take those herbs from the diet shop?"

Yes, Heather, they are safe and good. But you must take them like the medicine label says. It can't hurt to try them."

Activity I:

Research the general facts of diabetes. Your main objectives are the following:

1. Distinguish between Type 1 and Type 2 diabetes by comparing and contrasting their definitions, bodily effects, warning signs, target groups, and current treatments in a table.
2. Look up statistics to share concerning both types of diabetes.
3. Know the function of insulin and its involvement with diabetes.
4. Why does diabetes cause a great risk of cardiovascular disease?
5. How do blood triglycerides factor into this?
6. Is there a cure for diabetes?
7. What are some ways to control insulin resistance?

Activity II:

What should Morgan do? As a group, determine a recommendation for Morgan as your client.

1. Research the pros and cons of the Atkins' Diet.
2. Research health store supplements containing the herbs such as fat absorbers, appetite suppressors, and ephedra. What do major healthcare organizations say about it?
3. Learn about the possible effects of exercise to control weight.
4. Try to tie in aspects of each weight loss approach with the risks that Morgan now has with Type 2 diabetes. For example, should her risk for kidney disease and cardiovascular disease affect her choice?
5. Note if each approach stresses exercise or just dietary changes. What is the importance of exercise?

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