Who Runs the World: The Effect of Case Studies and Biotechnology Laboratory Techniques on the Confidence and Science Career Interest of Underrepresented female Anatomy and Physiology Students

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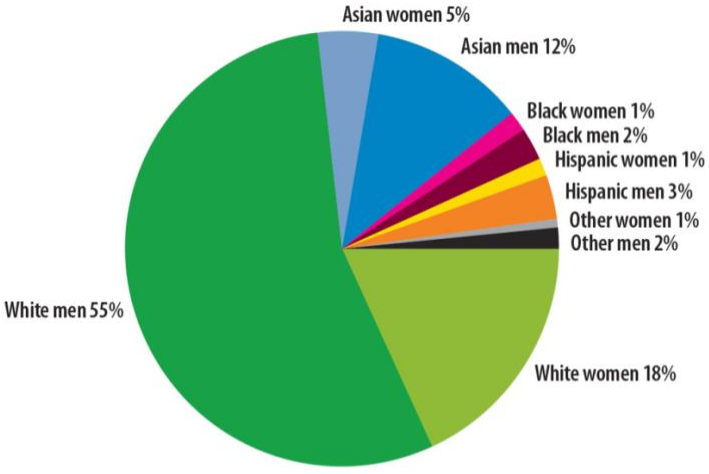
Abstract

This action research presents the findings of using both case studies and biotechnology laboratory techniques on the confidence and science career interest of underrepresented high school female Anatomy and Physiology students. Biotechnology lab techniques were implemented during the third quarter of the 2011-2012 school year by visiting the University of Florida campus. Case studies were integrated throughout the duration of the school year. Students' overall confidence and science career interest was measured at the beginning of the school year via class discussion and small group discussion. Surveys and questionnaires were taken twice after the initial discussions in order to gauge progress. After implementation of biotechnology lab techniques and case studies, an increase in confidence and science career interest was evident.

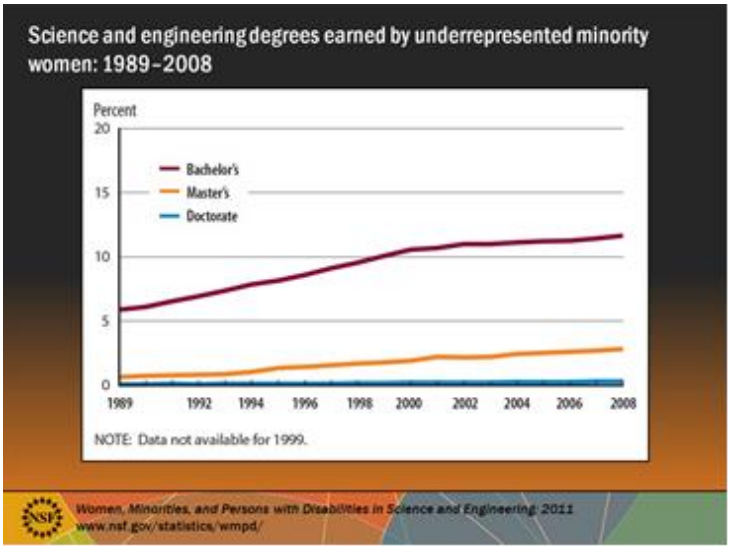
Rationale

The subject of under-representation in science is a topic that hits close to home. I am a Hispanic female and had to fight many misconceptions within my culture to achieve the science degree I currently hold. During my undergraduate course work, it seemed much of my battle with obtaining my degree was personal. Research shows I am not alone. Although the number of women with science degrees has risen, the numbers do not match the number of males with science degrees.

The gender gap is closing much faster than the huge difference seen when looking at the data for minorities. According to the 2011 National Science Foundation Women and Minority Report, 55% of scientists and engineers are white males. Women make up 26% of scientists but only 2% are Hispanic and Black (1% each). Although the number of minority women who are earning bachelor's degrees is on the rise, the number of minority women who earn doctoral degrees has remained nearly consistent.



NOTE: Hispanic may be any race. Other includes American Indian/Alaska Native, Native Hawaiian/Other Pacific Islander, and multiple race.



Why the low numbers in a field that craves applicants? There is still much research to be done in order to determine exact causes but there are three factors that are critical to a future in science: 1. Opportunity to learn science, 2. Achievement in these subjects and 3. Students' decisions to pursue them. Minorities and women lose ground on all three factors. Girls and minorities are typically encouraged less than white males and have few science and math related opportunities either in school or out. However the good news is, "when encouragement and opportunities are present … these groups seem to respond in much the same way as white males – with interest and participation." (Oakes, 1990)

Due to this data, I feel as though campus visits, guest speakers and open discussions about science can encourage students to explore science as a possible career option. The support and exposure is a vital part for increasing our numbers in a booming industry. Challenging, but not impossible, curriculum gives the students opportunities to learn the science which targets one of the three critical factors. Allowing them to take charge of their own learning by guiding them can make them feel as though they have the ability to succeed. Often times the students do not feel they can do well in a science class because it has been ingrained in their minds that science is too hard for them (Aschbacher et. al., 2010)

Another hypothesis points to a very basic idea: Role models. "In the case of ethnic minorities the disparity is even greater, so that a Black or Hispanic individual, male or female, is very likely to go through training without a single role model of his or her ethnicity." (Danielle, 2006, xxii) Many of my students do not associate science as a choice because no one in their family knows about science as a career. It becomes an issue of maintaining the delicate balance of culture and self-identity.

High school seems to be a time when most of the students are trying to determine their life path. Often they are also very vulnerable to feeling as though they are not smart enough for a certain career choice. It is my responsibility to change how I teach to target students for them to master the concept, not the learning style in which is the most

convenient for me. “There is also some direct evidence that boys benefit from conventional teaching strategies, while girls and minorities benefit from strategies using cooperative and “hands-on” activities.” (Oakes, 1990, 55)

My school is fortunate enough to have a vast array of cultures roaming around in its hallways. The school is roughly 14% white and 86% minority students. Of the minority students, Hispanic students make up the largest subgroup at 59%. Since the Hispanic population is so large, it has a big impact on the dynamic of the school. Another great aspect of the school is its fairly equal balance of male and female students. In regards to gender, the opportunities for both males and females are the same for many of the programs (including sports) on campus.

By incorporating group work and biotechnology, I targeted my underrepresented female students for them to realize that science is something they *can* do. This built their self-esteem in more than just science and can encourage them to tackle other “intimidating” events such as attending college. According to the National Science Foundation’s Division of Science 2011 resources statistics, ‘’underrepresented minorities—blacks, Hispanics, and American Indians—are less likely than whites to attend college or to graduate, but for those who do graduate, the degree patterns are similar to those of whites.” (NSF, 2011) The goal will be to get them there!

Overall, the purpose of my research was to see if the unconventional methods of using case studies and biotechnology activities could indeed change the confidence and attitude toward science careers of my underrepresented students. I provided hands on activities with biotech labs, challenged their way of learning with case studies and then collected data to determine if these activities had an impact on their confidence and attitude toward science careers. I wanted them to understand that science is not simply another boring difficult class but a very real possibility for their future.

Action Research Intervention

I selected 30 female students to collect data from. Due to lack of resources, only my target female students participated in the campus visit and the biotechnology labs I selected that corresponded to my current standards.

An important aspect to my action research was maintaining a careful record of areas of concerns of my underrepresented students. In order to monitor and address the concerns of my students, I had to make time throughout the school year to conduct small group discussions to allow the students to discuss their concerns with me. It was important for me to acknowledge their concerns and address misconceptions throughout the year. This instilled a sense of community amongst the class. I was able to use these small groups to gather data about the changes these girls were having in regards to their outlook on science careers.

In addition to these small group discussions, the following interventions were used:

1. I incorporated case studies that focused on knowledge of body systems and involved problem-solving skills and higher order thinking and questioning. Case studies were completed within small groups (3-4 students) and encouraged students to learn how to cooperate with one another and compromise. Each student had a role amongst their group: Clue Recorder, Reader and Writer. If the groups were larger than 3 or 4, roles were doubled up (two readers or two writers). As the reader read the case study aloud to his/her group, the clue recorder made notes about any important fact (patient's temperature, a certain food was ingested, etc.). The Writer wrote down the questions and answers for the group. As the year progressed and more systems were taught, the case studies became cumulative and focused on getting the students to hone in on prior knowledge. However, finding such case studies proved to be difficult. Often the case studies had to be on a singular system. Case studies were in various formats such as printed hardcopy, PowerPoint clicker cases and online case studies with the most popular being a jig-saw type of printed case study. I started with smaller mini-case studies at the beginning of the year but quickly jumped into larger case studies which the students handled well. The case studies were from the National Center for Case Study Teaching in Science from the University of Buffalo. I selected particular case studies based on the unit being covered. Each case study on the site is separated by grade level and then subject, making it easier for me to select based on my class topic and difficulty.

2. The implementation of the biotechnology labs and techniques was combined with the campus visit on March 15th. The labs done were Pipetting by Design, Harry Potter genetics and a strawberry DNA extraction lab. The main purpose for these labs was to show students real-world laboratory skills/techniques used in every day research labs throughout the world. The basic science needed to understand these labs was presented to the students in previous lessons before the field trip. Power point presentations and practice sessions were had throughout the weeks leading up to the field trip. The campus visit to the University of Florida with the students allowed the students to get a feel for what life will be like as a science undergraduate. A small tour of the campus was provided. The trip included one of our guidance counselors to provide more insight to what is needed in order to achieve entrance to a university in regards to credits and classes needed for graduation.

Connections to Bench to Bedside Summer Institute

The ideas and information for the biotechnology labs were based on the concepts covered during the Bench to Bedside Summer Institute. The materials for the labs were provided by the Bench to Bedside program. The PowerPoint presentations that have been provided by the professors during the institute have been, and will continue to be, referenced when addressing certain issues in medicine such as diabetes, PKU and scar formation.

Data Collection and Analysis

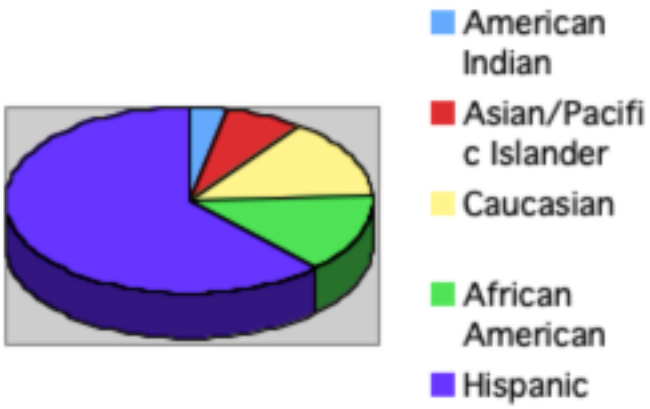
I collected both qualitative and quantitative data. The quantitative data was basic data on the number of students who plan on attending college or majoring in a science. Qualitative data was done when observing students during their discussion and participation in small group work during case study days. It was also done for analysis of their responses to the teacher made surveys I implemented.

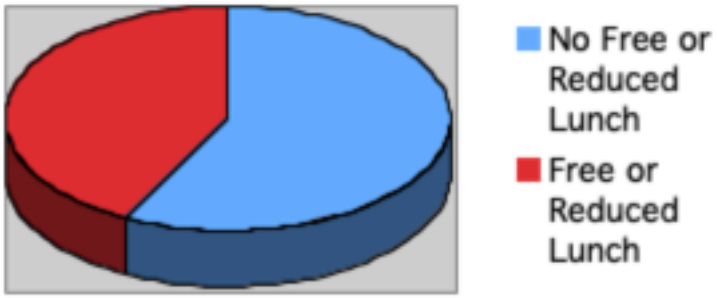
The initial survey was based on the Assessment Tools in Informal Science website which provides several surveys to assess the attitudes of students toward science. It was also given to all students as I had not selected my target group. However, the data on this survey proved to be difficult to tie into my particular research. I decided it would be best to come up with a survey that better assessed a student's attitude toward science and challenges facing their education. The survey included questions concerning careers and majors in college. This survey was given during quarter two of the school year… a few weeks before the mid-term. This survey was only provided to my female students. A copy of the first survey given is provided at the end of this paper.

The last survey was a modified version of the survey taken during quarter two. This was taken after the campus tour of UF. The survey focused on questions regarding education and science interest. This particular survey was then given to only my select 30 female students. I could then use their previous surveys to have a before and after on their views.

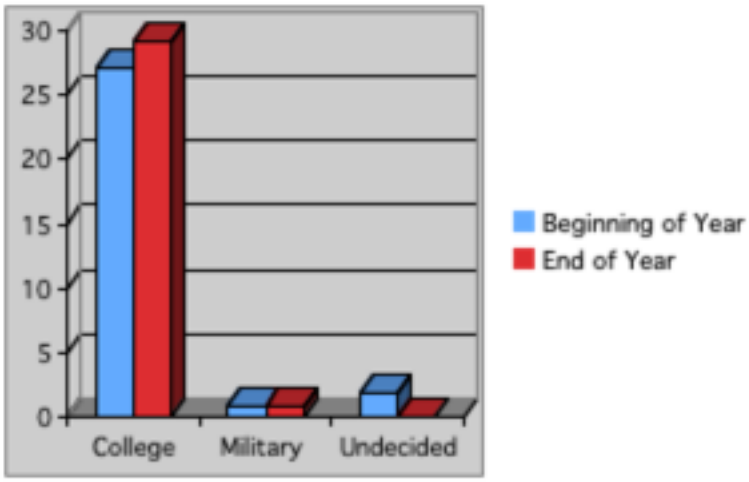
Data is displayed below as bar graphs or pie charts depending on question being asked.

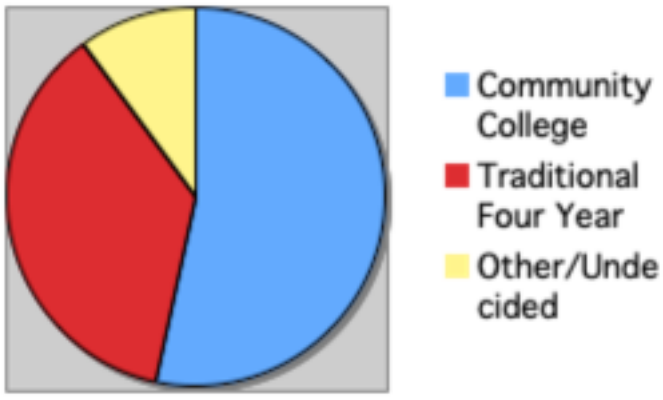
Nationality Breakdown of 30 Target Female Students





Economically Disadvantaged (free or reduced lunch)
College Plans

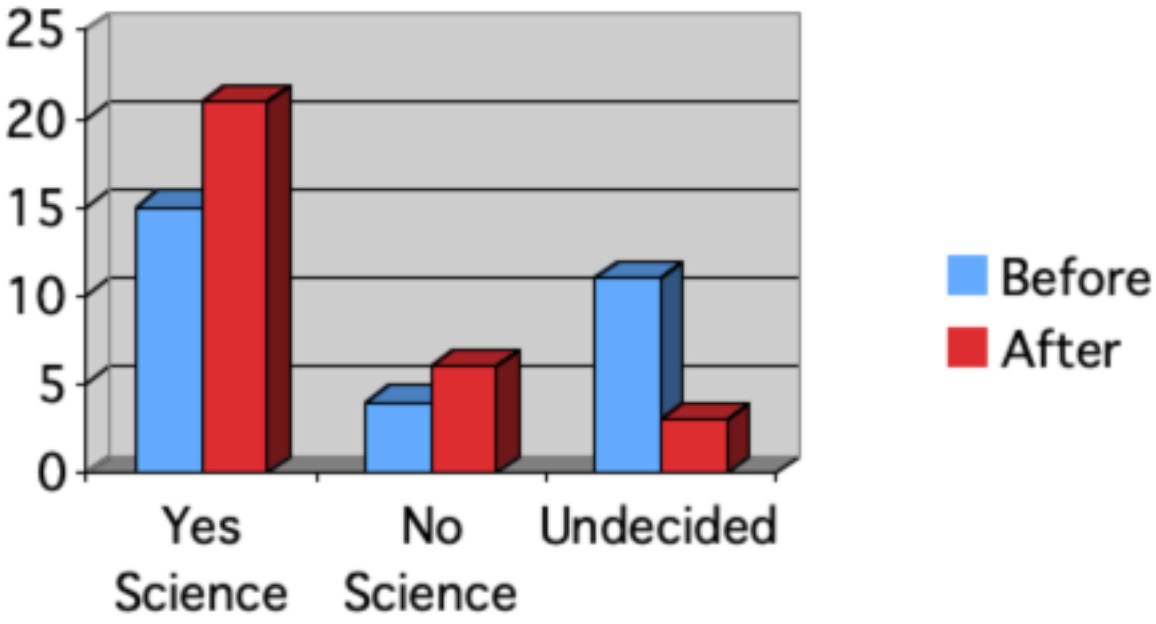




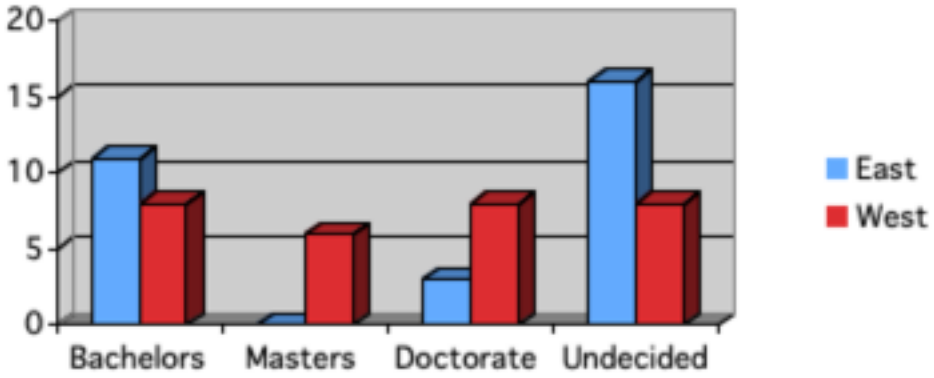
College Plans (Continued)

When questioned on the reasons why the girls wanted to go to a community college, all stated financial concerns as their primary reason to start at a community college. Those who were undecided said their choice depended on the amount of scholarships available before making a decision.

Attitude Toward Science Careers/Majors Before vs. After



Level of Education Goals Before vs. After



Level of Education Goals Before and After (Continued)
Although the numbers would normally be amazing, many of the girls were not aware that becoming a medical doctor meant receiving a doctorate degree. This may be a reason why the number of doctorate degrees increased by the time the second survey was taken.

Use of biotechnology helpful in learning?
100% of the girls responded that the use of biotechnology in the classroom will increase student's interest in science and possibly encourage students to major in science.

Final Thoughts
Implementation of the case studies alongside a hands on experience affected all girls regardless of their future goals and current academic standing. GPAs for the target students ranged from 2.8 – 4.4. Based off of the collected data using surveys and small group discussions, the target group showed improvement in confidence and science career interest with the use of case studies and biotechnology laboratory techniques. Many students were simply unaware of the terminology used for degrees, some were confused as to what their desired field required of them.

Literature Cited

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National Science Foundation, Division of Science Resources Statistics. 2011. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2011*. Special Report NSF 11-309. Arlington, VA.

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Budget and Budget Justification

- Biotech Labs – *Locker/Free*
  - These labs were provided by UF's Bench to Bedside Summer Institute.
- Charter bus to UF – *$833; Escot Bus Company*
  - Charter bus was needed since we traveled for over two hours from Orlando and returned after school hours. Price was $27 per student to cover bus fee and driver tip.
- Case Study and Survey Print Out – *Part of print and copy allowance/Free*
  - The school allows copies to be made when given appropriate amount of time. No case study will need to be laminated and therefore was printed at no cost.

Cost Total: *$833*

Permissions

Permission to conduct a field trip to UF was acquired from the appropriate administrator and UF coordinators. Parent permission was granted for the field trip for each student. Photo release forms were needed for photography and filming which occurred during the campus visit. No other permission was needed.

Modifications from Original Proposal

The original action research proposal was going to measure the problem solving skills alongside the confidence and science career interest of my underrepresented female students. The omission of "problem-solving" occurred due to lack of initial measurement of problem solving skills. Determining which method to use in order to gauge these skills proved to be too difficult with the minimal time allotted before needing to move forward with benchmark testing. Having group discussions and doing at-home surveys were much easier and manageable for data collection on confidence and science career interest.

Learnings from Action Research

The students who participated in the labs at UF all unanimously agreed that the use of lab equipment is part of the learning process. Unfortunately there is a high cost in acquiring technology within the classroom and with budget cuts across all classes, it seems virtually impossible to meet the want. I found it extremely difficult to incorporate some labs due to lack of planning on my behalf. Many of the topics that could be used in conjunction with the locker labs are based on biology topics that would fit into my curriculum *indirectly*. Since time is so precious when trying to fit in many benchmarks, "indirect" doesn't always fit into the pacing guide. Next time I will definitely make the indirect topics fit better into the guide by planning biotechnology days.

Case studies have always worked with my class. In fact, I can only foresee myself using more case studies in the years ahead and perhaps getting the students to write their own case studies.

Surveys on attitudes toward science would be handled differently next year. I would like to quickly find my target group and then implement the same survey throughout the year to get a better idea of their gains.

The action research process is time consuming but a great way of writing down goals for your students. When goals are stated for certain best practice methods, it forces the teacher to fit said methods and data collection into the class. Often, as teachers, we forget to push ourselves with using new methods and techniques and gathering necessary data to see the growth in our students.

Dissemination

After the Summer Institute, I looked through my benchmarks and tried to fit some of the topics discussed over the summer into the curriculum. Most of the topics related to health were easier to insert or easier to reference. Any topic needing computers (the virus computer game, for example) could not be done due to lack of computers in the classroom or availability of computer lab time. It was simply a matter of listing all lectures covered during the summer institute and highlighting which topics were closely related to the human body and health.

The information (power points and lab ideas) provided over the summer was shared with colleagues during monthly PLC meetings. Department meetings are broken down into sub specialties and I joined the PLC group that decided to incorporate case studies into their lessons. My students were all aware of my action research because I shared the information on day 1 of the class.

Survey 2 (given during second quarter)

The following survey will help with my UF action research report. Please be completely honest and don't worry, this has no correlation to your grade ☺

I like science:	False	Mostly False	I do not know	Mostly true	True
I find science easy:	False	Mostly False	I do not know	Mostly true	True
I believe science is important:	False	Mostly False	I do not know	Mostly true	True
I want to do well in science:	False	Mostly False	I do not know	Mostly true	True

Short Response

Do you plan on going to college?

Do you plan on majoring in science?

As a child, were you encouraged to participate in science (going to the zoo, science museums, buying science kits, etc.)?

If you were encouraged as a child, who encouraged you the most? Parents? Teachers? Siblings?

If you are interested in science now but were NOT encouraged, what got you involved in science as a possible career?

What is the highest degree or level of education your parents have?

Do you think your parents' education affects your choices for your future goals?

What are some concerns you have about going to college? (this can be anything, financial, emotional, etc.)

Do you feel you are prepared for college?

Do you want go beyond a four-year degree --- masters or doctorate program? Why or why not?

If you are going into a science-related field … what made you decide to do so?

Are you worried about majoring in science? Why or why not?

If you are not majoring in science … why not?

Do you feel as though being a female in a male dominated field is intimidating (scary), exciting or both?

Do you know any scientists or someone in the medical field? What do they do?

Does your family encourage you to do well in school?

Does your circle of friends or your significant other encourage you to be smart or do you find you have to hide your intelligence from them?

Survey 3 (given after UF field trip)
Hi girls,

Below you will find 16 questions that I would like for you to answer for my final report for UF. If you could answer this today and email it back by tomorrow, it would be the best! Respond to me only so the other 29 girls don't have to see your answers, lol. Literally hit "reply" NOT "reply all" and you should be all set.

There's one typo on number 12 ("true or false" not "true or falsr"). If you don't feel like answering a question, just type "prefer not to answer". You can also type whatever your heart desires for any question.

Any feedback is great but this survey is a start :)

Gender:
Nationality:

1. What is your current GPA?

2. Will you be the first person in your family to graduate high school?

3. Do you plan on going to college?

4. Will you be going to a four year college (UCF, UF, USF, etc.) right away or going to a community college?

5. If you are going to a community college first, why?

6. Has anyone in your immediate family graduated college? (mom, dad, etc.)

7. What or who motivates you with school?

8. Do you plan on majoring in science? Why or why not?

9. Did the field trip with UF excite you for college? How?

10. Do you feel you have more or less questions about college after this trip?

11. Do you think other students would benefit from field trips such as these?

12. True or Falsr: Biotechnology labs (such as the ones you ran at UF) are meaningful.

13. Do you plan on getting a 2 year degree (AA or AS), bachelors degree (4 year), masters or doctorate?

14. Do you feel money (paying for college, living, books) influences students your age?

15. If someone were to tell you a particular field, major or job was too difficult for women or for underrepresented minorities, would you start to question your educational decisions? ("maybe they're right..." "why am I doing this?" etc.) or what would you say to that person?

16. What is the number one issue facing high school juniors and seniors? (doesn't have to be school related)

-Vanessa Lopez

Sample Case Study

Sweet Indigestion: A Directed Case Study on Carbohydrates

By Peggy Brickman, Department of Plant Biology, University of Georgia

Part I—Of Cows and Carbs

"What's so funny?" Gwen asked as she slid next to her friends Sara and Emily at the library.

"Read this," Sara said. "I'm thinking about getting my dad vaccinated."

S Y D N E Y, Australia, June 7

Australian farmers are signing up their sheep and cattle in droves to take part in a vaccine program aimed at reducing harmful methane gas emissions from their animals and help take the heat off global warming. Methane is a greenhouse gas more potent than carbon dioxide and farm animals produce a lot of it.

Australian scientists said today early results show they may be able to reduce methane emissions per animal by about 20 percent a year, or the equivalent of 300,000 tons of carbon dioxide a year if they can vaccinate three million animals. The methane vaccine discourages Methanogenic archae, organisms which inhabit the animal's digestive system and which produce methane by breaking down feed.

Reuters 2001

Gwen laughed, "Your dad? What about your dog? He's got the real problem. But seriously, is farting a major cause of global warming?"

"Well, not all of it, but greenhouse gases could be reduced if people stopped eating meat. Cows actually produce the vast majority of methane released in the U.S." Emily replied.

"300,000 tons of CO2 in Australia alone," Gwen said. "I wonder how much people produce?"

"When I visited Space Camp we learned about how the astronauts deal with noxious fumes," Sara said. "The average astronaut expels about a half liter of gas a day from bacterial break down of undigested carbohydrates in the large intestine. Maybe we all should be vaccinated. You both have been dieting, I bet you think you're eating a lot less carbohydrates than before. You could be our first test subjects."

"But what are carbohydrates exactly?" Emily asked looking at Gwen. "And which are undigested?"

Questions

Here's a list of what the girls had eaten so far:

For breakfast—Cheerios with oat bran, a tall Latte with skim milk, and a PowerBar®.
For lunch—Coke and a salad with lettuce, cabbage, tomato, shredded carrot, green peas, kidney beans, and tuna fish.

1. Underline all foods containing carbohydrates.
2. Come up with a rule to help you identify foods containing carbohydrates.
3. How are carbohydrates made normally (i.e., what organism makes them)?
4. Which ingredient would cause gas? Why are some foods digestible and others

Sweet Indigestion by Peggy Brickman Part II—Label Analysis

The girls checked out a nutrition textbook and learned that almost all of the foods they were eating contained carbohydrates. But how much gas is produced in your intestine depends on the type of bacteria you are harboring and whether or not you eat the following carbohydrates that aren't well digested.

Gwen's list of carbohydrates that aren't well digested:

* Simple sugars:
    - o Dried beans, peas, and lentils containing the tri- and quatro-saccharides Raffinose and Stachyose
    - o Lactose
    - o Fructose
    - o Sorbitol, found in fruit but also an artificial sweetener
* Starches
* Insoluble fiber

Analyze the PowerBar® food label below and then answer the questions that follow.

PowerBar Nutritional Label

INGREDIENTS: HIGH FRUCTOSE CORN SYRUP WITH GRAPE AND PEAR JUICE CONCENTRATE, OAT BRAN, MALTODEXTRIN, MILK PROTEIN ISOLATE, RICE CRISPS (MILLED RICE, RICE BRAN), PEANUT BUTTER (ROASTED PEANUTS, SALT), BROWN RICE, GLYCERIN

THE ORIGINAL PERFORMANCE ENERGY BAR™

Nutrition Facts

Serving size 1 bar

Calories 240

Calories from Fat 30

*Percent Daily Values (DV) are based on a 2,000 calorie diet

Amount/Serving	% DV	Amount/Serving	% DV
Total Fat 3.5g	5%	**Total Carb** 45g	15%
Saturated Fat 0.5g	3%	Dietary Fiber 3g	12%
Cholesterol 0mg	0%	Sugars 14g	
Sodium 120mg	5%	Other Carb 28g	
Potassium 130mg	4%	**Protein** 10g	20%

Questions

1. What percentage of the carbohydrates in the bar is simple sugar?
2. Can the girls omit all carbohydrates that are not well digested (like those in Gwen's list) from their diet? What are these carbohydrates used for?
3. What are the differences between simple sugars, starches, and fiber?
4. Use this PowerBar label to find all the ingredients that are carbohydrates of the following classes:
    * Simple sugars
    * Complex carbohydrates like starches
    * Complex carbohydrates that contain fiber
    * Carbohydrates that would produce gas according to the list aren't?