Assessing
Group vs Individual
Problem-Solving Strategies

Marcy Osgood
Department of Biochemistry and Molecular Biology
University of New Mexico School of Medicine
Albuquerque, NM
Biochemistry Education Research at UNM
-In School of Medicine
-But, Undergrad major
Demographics:
Hispanic: 44%
Anglo: 43%
Native American: 10%
Black: 2%
Asian: 1%
Overall goals of our research (and educational) program:
provide role-modeling, practice, and formative and summative assessments in problem-solving strategies
Earlier work: Using Biochemistry-content PBL cases in small face-to-face groups


How to implement in classes of 60-100?
Do it on-line...
Progressive-Reveal Group PBL-Case

Problem → Hypothesis

Reflect

Investigate

Integrate → Evaluate

• Problem presentation is vague
• “Resources” are limited and data requests must be justified
CSI: Albuquerque

Active Case File:
The mysterious death of a beloved professor

A true case, only the names and situation have been changed to protect the guilty
The Suspects

The graduate student

The much younger colleague

The professor’s mourning widow

The chairman

The Suspects
More Stuff to Think About...

I agree we should definitely find out more stuff about the fish. Are we just grinding up the whole fish and feeding it ground up fish I don't really know where to start! The ATP killer could be anything, even something the fish eats... Maybe we should also start thinking about what cellular functions the mystery compound must be disrupting i.e. gl directly affecting the ATP molecule? :confused:

MCMontoya

Yikes!

I don't know exactly where to go from here, but I think Ahmed has a good idea. I think finding out the pH of the er that you mentioned that it could be something the fish ate, maybe some type of bacteria, I think it's something to

Maria

jgonz01

Question/Clarification

Brandy brings up an interesting question. Is there a problem generating ATP or is the issue with ATP consumption?

Generating ATP: ie.
Glycolysis, Krebs, Electron Transport,

Consuming ATP: ie.
Enzymes, biosynthetic reaction, motility, cell division, active transport, etc...
Problem-Solving “Domain”
Categorization of Student Postings

• Is the student generating reasonable hypotheses?
• Is the student proposing an appropriate investigative strategy?
• Is the student correctly evaluating supplied data?
• Is the student integrating conclusions from the data with known mechanisms or facts?
• Is the student reflecting on their own contributions, or planning to address potential new problems as a result of their proposed intervention? (also includes summarizing)
We saw, over a 5-year study, that there were common patterns of individual student “roles” within the group discussions:
"The Shotgun Investigator"
"The Summarizer"

- Hypothesize
- Investigate
- Evaluate
- Reflect
- Integrate
“The Lonely Scientist”

1. Hypothesize
2. Investigate
3. Evaluate
4. Integrate
5. Reflect
“The Lonely Scientist”

- Reflect
- Hypothesize
- Integrate
- Evaluate
- Investigate
“The Lonely Scientist”

Hypothesize

Reflect

Integrate

Evaluate

Investigate
“The Lonely Scientist”

- Hypothesize
- Reflect
- Investigate
- Evaluate
- Integrate
"The Lonely Scientist"

Hypothesize

Reflect

Integrate

Evaluate

Investigate
“The Lonely Scientist”

Hypothesize

Reflect

Integrate

Evaluate

Investigate
“The Budding Expert”

Hypothesize

Reflect

Integrate

Investigate

Evaluate
IPSA
Individual Problem Solving Assessment
CASE: Carl D. Adipo

Carl D. Adipo is a 23-year-old Caucasian male who was brought into the local emergency room by a friend after he had fainted on the soccer field. At the ER, he was still very fatigued and confused with generalized muscle weakness.

What are your hypotheses to explain the cause of this patient's problems?

Enter one of your hypotheses and then press the [TAB] key to create your list. To add additional hypothesis to your list, type in your hypothesis and press the [TAB] key for each hypothesis. When you are satisfied with your list, press the appropriate button to either Record your list or to Erase your list and start over. You are limited to only the 5 most relevant hypotheses.

Hypothesis List
Initial blood work in the ER showed that Carl had normal plasma levels of electrolytes, calcium, phosphorus, and total serum protein, but a severely lowered level of blood glucose.

As part of Carl’s follow-up evaluation, and based on his hypoglycemia at the time of the fainting episode, a 32-hr fasting study was performed. Refer to the exhibits to see how his blood glucose, plasma triacylglycerols, fatty acids, and acetoacetate and β-hydroxybutyrate levels changed during the fasting study. When the resident looked at the data she stated that “there is a puzzle here” and then walked away. A medical student that is part of the care team immediately turns to you and asks you to help him with this puzzle.

(Press the [TAB] key to either erase your response or record your answer)
Case Presentation

Carl D. Adipo is a 23-year-old Caucasian male who was brought into the local emergency room by a friend after he had fainted on the soccer field. At the ER, he was still very fatigued and confused with generalized muscle weakness.

What are your initial hypotheses to explain Carl’s problem?
Carl was playing in a soccer game on Sunday afternoon. Carl tells you that he normally prefers to play goalie because "my endurance is not the best", but on this day the team needed him on the field. As such, he had been running hard for over 20 minutes. He stopped after one long full-field run, looked dazed, put his hand on his heart, and fainted. According to his friend, he took several minutes to regain consciousness.
Past Medical History
Carl reports that he had always been in good health until his late teens when he was in a car accident and incurred a head injury. The injury resulted in epileptic episodes that are now well-controlled by regular administration of anticonvulsant drugs. Carl tells you that he is otherwise healthy with no other medical conditions of which he is aware.

However, when asked if he had ever had any fainting episodes before, he timidly reports that he has. In each case, the episodes were preceded by “pushing myself too hard.” Carl is a vegan (eats no meat, eggs or milk), though he insists that he gets plenty of protein from vegetable sources.
Evaluate
Initial blood work in the ER showed that Carl had normal plasma levels of electrolytes, calcium, phosphorus, and total serum protein, but a severely lowered level of blood glucose.

As part of Carl's follow-up evaluation, and based on his hypoglycemia at the time of the fainting episode, a 36-hr fasting study was performed. Refer to the exhibits to see how his blood glucose, plasma triacylglycerols, fatty acids, and acetoacetate and β-hydroxybutyrate levels changed during the fasting study. You can access these results by selecting the “Exhibits” menu item on the top of the screen and click on the “Evaluate” option.
Glucose (●)
Triacylglycerols (X)
Fatty acids (■)
Acetoacetate + β-Hydroxybutyrate (▲)
When the resident looked at the data she stated that “there is a puzzle here” and then walked away.

A medical student that is part of the care team immediately turns to you and asks you to help him with this puzzle.
Glucose (●)  
Triacylglycerols (X)  
Fatty acids (■)  
Acetoacetate + β-Hydroxybutyrate (▲)

Blood Glucose mg/dl

Plasma TAG mg/dl

Plasma Fatty Acid mEq/L

Ketones

Time (Hours)
Integrate
A muscle biopsy revealed accumulation of lipids in the myocytes: a liver biopsy showed fatty deposits as well.

Peripheral blood lymphocytes are often used to investigate a patient’s metabolism in vitro. Unlike the liver, lymphocytes do not synthesize glucose; however, the DNA synthetic response to mitogen is also an energy requiring process and can be used to investigate energy metabolism. In lymphocytes, energy for DNA synthesis can be supplied by either glucose or fatty acid. However, unlike in the liver, in lymphocytes fatty acid must be supplied as triacylglycerols (TAGs) in lipoproteins instead of as free fatty acids bound to albumin.
Mr. Adipo's lymphocytes were stimulated with mitogen in glucose-depleted culture media, and DNA synthesis measured by following the incorporation of $^3$H-Thymidine into DNA. The cellular energy for this experiment was supplied by lipoprotein constructed with either normal-length fatty acids, or with short chain fatty acids.

The figure below illustrates the response of Mr. Adipo's lymphocytes. When lymphocytes from a control individual replaced Mr. Adipo's lymphocytes in this experiment, both curves looked like the short chain fatty acid curve (X) below.
Normal lipoproteins

Lipoproteins constructed with short chain fatty acids

DNA Synthesis

Time (Hours)

0 12 24 36
Reflect: Carl was suffering from a deficiency of carnitine, caused by his long-term use of the anticonvulsant drug valproic acid, which decreases synthesis of carnitine. Synthesis occurs in the liver and kidney from amino acid precursors, especially lysine. Similar deficiencies can occur in patients undergoing regular renal hemodialysis (which increases excretion of carnitine), or other toxic insults to liver or kidneys due to treatment with drugs for AIDS or long-term bacterial infections. Dietary sources of carnitine include meat and dairy products.

This question contains two parts; you must answer both for full credit. Part 1: How would you counsel Carl about dealing with his recurring fainting episodes? What kind of nutritional and lifestyle suggestions would you make? If he does not deal with his carnitine deficiency, what predictions do you have about future health problems for Carl?

Part 2: Critically evaluate your performance on this IPSA.
Hypothesize: Student 04 response and grading rubrics

File 04.txt

Starts 11 Duration 0.7755425 Date 4/29/2008

Hypothesize Investigate Evaluate Integrate Reflect

Hypothesis 1
phenylalanine dehydrogenase is inactive- then phe goes into alternative pathway.

Hypothesis 2
hydroflouratereductase is inactive-thf is not regenerated slowing the normal phe

Hypothesis 3

Hypothesis 4

Hypothesis 5

Hypothesis 6

Top Hypothesis
I would like to know how his mother was treating Kenny

Rubrics can be placed here
SCORING IPSA RESPONSES

Hypothesize

Reflect

Integrate

Evaluate

Investigate

Satisfactory Performance

Exemplary Performance
SCORING IPSA RESPONSES

Hypothesize

Reflect

Integrate

Investigate

Evaluate

0

2

4

6

8

10

The diagram illustrates a scoring system for IPSA responses, with axes labeled Reflect, Integrate, Investigate, and Evaluate, and a central point marked with a score of 10.
SCORING IPSA RESPONSES

Hypothesize

Reflect

Integrate

Investigate

Evaluate
SCORING IPSA RESPONSES

Hypothesize

0
2
4
6
8
10

Reflect
Integrate
Evaluate
Investigate
Sequential Testing (Student 1)
Sequential Testing (Student 1)

- Plan
- Integrate
- Evaluate
- Investigate
- Hypothesis
Sequential Testing (Student 1)

- Hypothesis
- Plan
- Investigate
- Integrate
- Evaluate
Sequential Testing (Student 1)
Sequential Testing (Student 1)

Hypothesis

Plan

Integrate

Investigate

Evaluate
Sequential Testing (Student 1)

Hypothesis

Plan

Integrate

Evaluate

Investigate

*
Hypothesis

Reflect

Integrate

Evaluate

Investigate

Student 2
REPRESENTATIVE INDIVIDUAL PATTERNS

Pattern A

Pattern B

Pattern C

Pattern D
A. Some students need intervention...and may still not improve over time.
A. Some students need intervention...and may still not improve over time.

B. Some students improve without additional strategies.
What's Next?

-What are the most effective interventions for students who are consistently unsuccessful in problem-solving, in groups and as individuals?

-Are there differences in use/acceptance/benefit of problem-solving practice assignments between student groups (GPA, age, gender, cultural background)?

-Do faculty perceive a benefit in having problem-solving profiles of students? Which students are “worth” all this work?
Discipline-based education research is like...
Discipline-based education research is like...