PEER-LED TEAM LEARNING
LEADER TRAINING

LEADER TRAINING MODULE:
WHY THERE ARE NO ANSWER KEYS

"We live in a universe whose age we can't quite compute, surrounded by stars whose distances we don't altogether know, filled with matter we can't identify, operating in conformance with physical laws whose properties we don't truly understand."
-Bill Bryson in A Short History of Nearly Everything

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Section A: Introduction

Algorithmic vs. Conceptual Understanding

An algorithmic approach uses a "formula" or "procedure" to solve a problem. This approach is a major benefit when a fast response is needed. However, any error in the "formula" or "procedure" can be catastrophic, especially if the person who applies the solution does not check if the answer is reasonable or who has little understanding of how the algorithmic approach was developed. Choosing the wrong algorithm or procedure to solve a given problem leads to nonsense.

A conceptual approach uses fundamental concepts to develop a solution to a problem. This approach is a major benefit when problems are open ended, may have competing solutions (causes of acid rain, global warming, etc.), or when algorithmic approaches are unclear. While this approach is a major benefit when addressing many real world science and math problems, the derivation for a solution can be tricky, especially if the person doesn't have a clear understanding of the concepts needed to solve the problem. Finally, the reasonableness of the solution (as in algorithmic problem solving) needs to be checked.

While an answer key is useful in determining if an algorithmic solution has been correctly calculated, it offers little to help in understanding how reasonable a solution we have. Similarly, knowing the algorithm or formula to solve one type of problem does not guarantee an understanding of the concepts (Nurrenbern & Pickering, 1987; Johnson & Johnson, 1992; Nakhleh, 1993).

Answer Keys and PLTL

FAQ: *"Why don't peer leaders or students get the answer keys?"*
Answer: *"There are no answer keys."*

This question and answer is among the most common exchanges of PLTL leaders with their groups, of faculty with their PLTL leaders, and even new PLTL (and sometimes experienced PLTL) faculty with other PLTL faculty. Why?

We are all very familiar with using answer keys for studying science, math, and other conceptually and fact-filled subjects. For many of us, this is how our schooling was organized: do the problem and then check an answer key to see if you've got the correct answer. As we gained experience with problem solving, we tended to move away from reliance on "the correct" answer and develop a sense of what is involved in evaluating if a problem was solved correctly. However, at the elementary stage of learning, again, why not an answer key?

The short answers are that an answer key can shortcut the learning process and interfere with the group interactions. In this workshop, we will explore why an answer key can interfere with a good understanding of the material and tends to discourage collaboration with other students. Finally, we'll explore ways of communicating this to your group.

Is There an Answer Key in Science?

If science is fundamentally a way to gain understanding of nature and previously unknown phenomena, it is important that learning science mirror the scientific process. Clearly, new science does not come with an answer booklet, and part of learning science is to become comfortable with the loss of certainty that accompanies working at a frontier. The myth of the lone genius in science is just that, a myth. The reality of science is much closer to the team model in which many people either in the same room or by communicating across space and time each contribute a piece to solving the larger puzzle.

Section B: How to Conduct a Leader Training Session

Goals of PLTL-LT Modules

Modules should generally be completed in 50-60 minutes. In order to meet this goal, everyone in the group will have to work together to stay on task. If the group has some extra time, a more relaxed pace can be accommodated.

Choosing the Leader

Each week your group will select a different person to be the leader. Choose the leader for the following week at the end of the current week's session. The leader will be responsible for keeping the group on target and within the time limits assigned to each activity. They will help guide the group when the group is having trouble moving forward.

The Assessor

Each week, aside from the leader, your group will choose one person to write a short assessment regarding the module. This person should write how the module went, any problems that occurred, any positive feedback, what they would like to see changed/stay etc. This should be posted in the PLTL on-line folder.

Section C: Leader Training Activities

20 mins

Tooth Pick game

How to Play:
Each Player takes a turn crossing out as many "toothpicks" as desired in a single row of the given pattern. The player who is left with a single "toothpick" loses the round.

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a) Work in pairs to start this activity by playing several rounds of the "toothpick" game.

b) Now each pair of opponents will now team up to play another team for several rounds. Discuss your moves with each other before you play.

c) Each group of opposing pairs will now form a group of 4 to make a list of strategies they found useful for winning the game.

d) Each group of 4 will now present these strategies to the whole group.

Toothpick Game Questions

Is there a sure-fire strategy for winning?

Will one person always win if he or she knows the right strategy?

Think of a workshop scenario you have encountered involving a student requesting answers and/or a leader providing answers. How can you use what you have learned from the game to explain to that leader/student why we don't have answer keys?

20 mins

Scenarios

The following scenarios often occur in PLTL groups. As a group, choose one scenario and discuss how you would respond to that scenario. The assessor should record a summary of the discussion.

1. A student goes to see his professor during office hours, confused about how to find empirical formulas. When asked to explain how to convert from grams to moles to atoms as in one of the workshop problems, the student replied "Oh we don't really pair up and explain things in the workshops, we just work on the problems and compare answers." How does this approach (working on problems and comparing answers) differ from paired problem solving? How can you help this student?

2. One of the workshop problems asks students to construct a concept map. When you enter the room, one of the previous groups has already constructed a concept map and left it on the board. Your group decides to simply copy it and spend their time on the "real" problems, the ones most likely to be on the exam. How does copying a concept map impact the learning process? Does it help or hurt the group dynamics? What do you say to your students?

3. The first workshop problem uses a round robin approach. You set up the round robin, explaining how the first student will answer the first question with the agreement of the group, and then the second, and so on. However, the second student really seems to know how to do the problem and offers to write it on the board. The other members of the group seem appreciative, copying down the answer and nod in agreement when asked whether they understand it. Unfortunately, the first exam suggests that only the person at the board really understood the problem. Did this approach to problem solving develop algorithmic or conceptual understanding? How does the round robin approach affect the social dynamics of the group? How does it affect the learning process of the group? How can you make sure that everyone in the group really understands a problem?

4. The group is always trying to get the answers off the leader's workshop. You finally agree to go over the answers, but only at the very end of the workshop after the group works through every problem. One of the students gets a question wrong on an in-class quiz later in the week and complains to the professor that the leader gave the group the wrong answer. How has the answer key changed your role as the group leader? How has the answer key affected the learning process? Now what do you do?

10 mins

The Perry model

Consider the Perry model of intellectual development discussed below. Is it possible for a student to be at different levels of Perry's scheme for different subjects? Discuss your answers within your group. How can you use this to analyze the scenario you chose from the previous page?

Perry Model of Intellectual Development

In the 1950s and 1960s, William Perry interviewed hundreds of students at Harvard and Radcliffe and established four categories of intellectual and ethical development for college students (Finster, 1989; 1991). The four categories are given in Table 1 below.

Table 1: Perry's Scheme

- **Dualism.** Dualistic thinkers depend on right vs wrong answers to be presented to them
- **Multiplicity**. Multiplistic thinking allows for multiple viewpoints but is based on the notion that all opinions about a subject have equal weight.
- **Relativism.** Competing theories are based on content knowledge but since they can be in conflict, one arrives at the notion that there is no absolute right or wrong.
- **Commitment in relativism.** Students build a broad conceptual understanding drawing on the strengths of competing theories.

10 mins

Concept Mapping

Within your group, create a concept map for the Perry model. The assessor should make a copy of the concept map to share at the weekly meeting.

Use this space to create your concept map

Journal Response Questions

- Make a list of uses for an answer key
- Make a list of abuses of an answer key
- Has the issue of answer keys come up in your group? If so, describe the scenario and how you addressed it. If not, how do you plan to answer the question?

Please post your response to the PLTL on-line conference.

For more PLTL leader tips go to:
http://www.pltlis.org -- Look under "Resources" then "Leader Training."

References and further readings

Finster, D.C. (1989). Developmental Instruction: Part 1: Perry's Model of Intellectual Development, *Journal of Chemical Education*, 66, 659-661.

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