A Solution to the Problem-Solving Problem

by Chris Meyer

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Editor's note:
This is the third in a series of articles by Chris Meyer describing his experiences implementing a reformed physics program. Please e-mail him directly if you have any questions or feedback.

Well-honed problem-solving skills are sought after in many fields of endeavour: education, business, industry, and sometimes even government. Yet in traditional schooling, very little explicit instruction in this often mysterious art is ever offered. This is indeed a problem! How should we help our students learn the sophisticated problem-solving skills of experts? I propose an approach that my students know as the "Physics Challenge": a context-rich, story-like practical problem that requires careful analysis, planning, teamwork and the physical verification of the results.

Two skills associated with problem-solving readily distinguish an expert from a novice: the ability to quickly identify relevant ideas and information (defining the problem), and the ability to determine the general strategy for solving the problem (planning the solution). Experts use these skills almost instinctively, often unaware of the many decisions they make. Students are left observing the expert in a foggy wonder. The Physics Challenge focuses on developing these two skills. Over the past seven years, I have built upon the work of Pat and Ken Heller, from the University of Minnesota, who have developed an excellent structure for Cooperative Group Problem Solving (CGPS)[i]. My Physics Challenges are a modification of CGPS for the high-school level and have an added empirical twist.

A typical Physics Challenge presents a group of students with a problem concerning a practical situation involving simple equipment. Here is an excerpt from my favourite example, the "Washer Challenge":

Your group will be given a length of string, five washers and some tape. Your challenge is to attach the five washers such that when you release the string and the washers hit the ground, there is a steady sequence of sounds. This means a steady "clink-clink-clink-clink-clink." Not "clink, … clink …….. clink, clink, clink."

This is a real-world problem designed to present many challenges that students would not encounter even from "tough" textbook or contest questions. No measurements are given, forcing students to decide what quantities to measure. Students must translate the problem description from everyday language into clear physics terminology. For example, what physical characteristic do the steady clinks describe? There is no obvious, quick solution to the problem and there are few overt clues suggesting the correct approach.

Few individual students would be able to solve such a problem in the time allotted. Instead, the efforts of an organized group are required to succeed. Dead-ends and wrong turns are much more likely, so a considerable amount of group discussion and formal planning are required *before* jumping into the mechanics of a solution. In tackling these problems the groups follow a series of general steps that help them to meet these many challenges and focus on developing their skills.

A. The Picture: Draw a clear picture, measure the important information and indicate it using symbols and simple descriptions.
B. The Question: Create a specific physics question that will give the solution to the problem.
C. The Plan: Identify key concepts, steps and equations that may be useful.
D. The Work: Write-down specific equations and algebraically develop them.
E. The Results: Calculate a final result, justify it and then physically verify it using the apparatus.

Three elements of the Physics Challenge – the style of the problems, the structure of the problem-solving process, and the cooperative group approach - combine to yield a substantial improvement over traditional techniques[ii]. This system does involve a learning curve for both the teacher as well the students, but the results will greatly reward the energy

invested. For examples of more problems, please download the package of teacher resources[iii] available from my website. For a presentation introducing cooperative group problem solving and a sample solution to the Washer Challenge, please download my active learning course presentation[iv]. Good luck!

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[i] This is an excellent starting point for any teacher interested in learning more about these techniques: http://groups.physics.umn.edu/physed/Research/CGPS/CGPSintro.htm

[ii] Redish, E. *Teaching Physics with the Physics Suite* (John Wiley, 2003), 179

[iii] http://meyercreations.com/Physics/PER%20Gr12.htm

[iv] http://meyercreations.com/Physics.htm