

# **A Seventeenth-Century Analogue to Contemporary Physics Education Reform**

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## **Abstract**

Already by 1632 we find an educator warning that learners are liable to respond to questions “by rote, as parrats,” and recommending the method of questioning used by Socrates: “some dialogues in Plato were worth the reading, where the singular dexterity of Socrates in this kind may be observed and imitated.” The educator is George Herbert, the work is “A Priest to the Temple: the Country Parson, His Character, and rule of Holy Life”, and the activity at hand is catechizing the faithful. I am fascinated that Herbert identifies an issue still important to contemporary reformers of physics education, using the same words, and recommends the same remedy. In this brief note I describe my attempt to adapt in detail Herbert’s advice for the purpose of training physics teaching assistants.

Let us compare the words of educational reformers separated by almost four centuries:

I gave tutorials to ten students taking the first-year (IA) physics course at Cambridge University. The students—diligent, curious, and a joy to teach—had studied physics in high school for years and, as measured by grades and by scores on the Force Concept Inventory, with great success. However, using problems requiring estimation and conceptual reasoning (collected in the Appendix), I found that they struggle with fundamental concepts in math and physics. These difficulties—such as confusing velocity and acceleration or being unable to reason with graphs—prevent them from understanding or appreciating the beauty of physics, and force them into rote or parrot learning.

—“Observations on Teaching First-Year Physics” (abstract), Sanjoy Mahajan, <http://arxiv.org/pdf/physics/0512158.pdf> , 2005.

When once all have learned the words of the Catechism, he thinks it the most useful way that a Pastor can take, to go over the same, but in other words: for many say the Catechism by rote, as parrats, without ever piercing into the sense of it.

—“A Priest to the Temple” (Chapter 21); George Herbert (1632 or earlier).

I suspect Prof. Mahajan’s story will be painfully familiar to contemporary physics educators. I quote his abstract with approval, and commend the paper which it opens. Yet I can’t help but wonder that George Herbert (himself a Cambridge man) was telling the same story 373 years earlier.

To the best of my knowledge, Herbert’s linkage of “rote” and “parrat” to describe a degraded form of “learning” is the first such usage in English. I think that Herbert uses this linkage with the same meaning as does Prof. Mahajan, and indeed as do many of my colleagues who teach physics: he intends to relate something he has observed in his own students to something with which everyone is familiar, and considers to be bad, namely rote or parrot learning.

It is as if the same educational phenomenon which prevents physics students from “understanding” physics today prevented Herbert’s flock from “piercing into the sense of” the Catechism almost four centuries ago. Herbert might have something to teach me (I in turn

might tell him that to use “parrot learning” in a derogatory sense is perhaps a calumny against parrots).

It falls to me to train Teaching Assistants (TAs) to teach Physics at the University of Wisconsin–Madison. One particular problem is that we haven’t enough physics graduate students to do the teaching. In a recent semester, 19 of 57 TA positions remained open after all physics graduate students had been settled.

If I advertise that physics TA positions are available, I can expect to have 100 candidates, almost all of whom are engineering graduate students, and almost all of whom are citizens of India or China. Classroom culture in India and China is quite different from classroom culture in the U.S. How can I convey to these candidates—diligent, curious, and a joy to work with, for the most part—of the undesirable nature of rote learning, when teaching methods that reward it are all they have ever experienced? How might I convey to them methods which they might use to probe their students’ conceptual understandings? And how can I do this during the interview process, in order that the candidates will have an inkling of the criteria by which they will be judged?

After subjecting the candidates to written standardized tests and an oral examination, the final stage of the interview finds the candidate alone at the white board, armed with the solution to a physics problem and tasked with presenting it, and facing me, as I try to impersonate a class of physics students. What instructions might I give this poor person, in order to maximize the chance he or she receives an offer of a TA position?

Here is Herbert, a little later on in Chapter 21:

To this purpose some dialogues in Plato were worth the reading, where the singular dexterity of Socrates in this kind may be observed and imitated. Yet the skill consists but in these three points: first, an aim and mark of the whole discourse, whither to drive the Answerer, which the Questionist must have in his mind before any question be propounded, upon which and to which the questions are to be chained. Second, a most plain and easie framing the question, even containing in vertue the answer also, especially to the more ignorant. Thirdly, when the answer sticks, an illustrating the thing by something else, which he knows, making what he knows to serve him in that which he knows not...

In the old days, my instructions would be: first, make sure what you write on the board

is correct; second, face the audience when you are speaking; third, be interactive. The interactions which followed were usually of one of two types: “Does anyone have any questions? No? Then, moving on...” or “How do we solve the problem?” I find neither type to be effective in soliciting interaction in the Physics classroom.

Following Herbert, I have redone the third instruction. Nowadays I tell the candidates “Set up the problem thoroughly on the board, including writing on the board all given information, and a diagram; and once you have done this, permit yourself to write on the board only what the students tell you to write. Thus you will need to plan a chain of questions, and be able to compensate in case a student answers unexpectedly”. This is tedious; but the engineering students to whom I say it are nearly all able to produce a recognizable approximation to Socratic dialogue. If I video the candidate at the board, and we sit down later to watch the video, we almost always agree when a particular question was good or otherwise.

TAs need not spend class time solving problems at the board. However, I have found that using this method to introduce the skill of conducting Socratic dialogue (without mentioning Socrates, or Herbert) during the interview process pays off handsomely later, during TA training: the TAs focus their (often considerable) resources in the desired direction, and as a result there has been a noticeable decrease in student comments to the effect of “TA lectures during discussion” and “TA does not encourage questions”.

I fancy that Herbert would not mind too much that his words were turned to the promotion of secular learning. When he writes “sermons”, we might read “lectures”; where he writes “prayers”, we might read “homework”:

This is the Practice which the Parson so much commends to all his fellow-laborers; the secret of whose good consists in this, that at Sermons, and Prayers, men may sleep, or wander; but when one is asked a question, he must discover what he is.