Physics Education Research and the Teaching and Learning of Physics

Sergio Rojas
srojas@usb.ve
Physics Department, Universidad Simón Bolívar, Ofic. 220, Apdo. 89000, Caracas 1080A, Venezuela.

Abstract. A brief account of some recent controversies about the teaching and learning of physics is presented. A shorter version of this outcome was accepted by *The Physics Teacher*, but publication is still pending.

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In the October 2009 issue of *The Physics Teacher*, we were delighted to read a lively and enlightening genuine dialog on the important process of teaching and learning physics.[Sobel, 2009a; Lasry et al., 2009; Sobel, 2009b; Finkelstein et al., 2009] The lively discussion reminded me of recently debates[Głazek & Grayson, 2008; Klein, 2007b; Atkins, 2007; Millar, 2007; Klein, 2007a] which bring to light some key issues regarding the teaching and learning of physics which are dissected in published literature and in university hallways, reflected in statements such as "I have always been skeptical of general methods, tools, and jargon emerging from the inexact science, research into teaching, even though it has produced some interesting results."[Vogt, 2007]

Professor Wieman has also called for cautiousness when measuring teaching outcomes as one could create illusions about what students actually learn[Wieman, 2007], or in the words of Professor Sobel "Yes, in a special (possibly grant-supported) program, with smaller groups, with highly motivated instructors and students, with less content, students might do well, but that's not the real world."[Sobel, 2009b]

One could argue that these opinions result from the observation that physics is an intrinsically quantitative based subject, and from the belief that it is in physics classes where students should actually get training to apply what they have learned in their math classes. Yet, much of the recent *Physics Education Research* seems to overemphasize the importance of teaching the qualitative or conceptual physical aspects,[Mualem & Eylon, 2007; Hoellwarth et al., 2005; Sabella & Redish, 2007; Walsh et al., 2007] and to deemphasize the significance of standard mathematical reasoning, which are crucial for understanding physical processes, and which are not stressed, or even taught, because, rephrasing a passage from a recent editorial,[Klein, 2007b] they interfere with the students' emerging sense of physical insight. In addition, the lack of sensitivity to professors who want to be better teachers and to students who want to do well in their physics studies is further demonstrated in a letter written by a physics teacher to *The Assessment and Qualifications Alliance* (AQA) and to the UK Department for Education,[Grey, 2007] and by controversial outcomes coming from some publicized instructional practices.[Ates & Cataloglu, 2007; Coletta et al., 2008; Ates & Cataloglu, 2008]

Consequently, physics instructors continue to face the problem of finding suitable advice on how to approach the teaching of physics in the most efficient way and an answer to the question of how much time should be spent on intuitive, conceptual reasoning and how much time in developing quantitative reasoning [Rojas, 2008, 2009, 2010].

According to Professor Reif, perhaps the answer to this quandary is that "In science education the primary interest is not focused on the science itself, but on students who are trying to learn scientific knowledge and thinking. A truly scientific approach to education would thus need to strive for a better understanding of the underlying human thought processes and knowledge required for good performance in particular scientific domains."[Reif, 2008b] After outlining some basic issues on how to approach the question of performance in complex domains, Professor Reif further reminds us about the delicate complexity of the problem of teaching and learning by telling the story on how he was able to pronounce the sound corresponding to the letter "r" in English.[Reif, 2008a]

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