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Response to Griffiths

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Comments
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First of all, I would like to thank Prof. Griffith for his comments. The exchange has reminded me of the series of letters that appeared in *Physics Today* following the publication of an article by Chandralekha Singh, Mario Belloni, and Wolfgang Christian on improving the teaching of undergraduate quantum mechanics (see http://ptonline.aip.org/journals/doc/PHTOAD-ft/vol_60/iss_3/8_1.shtml). In those responses, both Griffiths and Travis Norsen argued that students' understanding of quantum mechanics would be vastly improved if they were taught more about the foundations of quantum theory, and I wholeheartedly agree with that sentiment. The thing is, Griffiths argued vociferously that this should be done by teaching students according to *his* approach, as outlined in his textbook *Consistent Quantum Theory*, whilst Norsen argued that it should be done by teaching students the de Broglie-Bohm theory, i.e. precisely the sort of theory that Griffiths argues strongly against in his response to my article.

I do not want to get into the arguments surrounding the various interpretations of quantum theory here, but only wish to point out that, for every physicist who advocates one particular view, one can find a number of physicists arguing the opposite. By any measure, the foundational problems with quantum theory should be considered unresolved to the satisfaction of the physics community as a whole. In light of this, I think that it is valuable to explore the whole space of possible interpretations, and to rule out possibilities via rigorous theorems, such as the PBR theorem, rather than by more contentious types of argument.

In general, I believe that the most sensible approach to both teaching and research in the foundations of quantum theory is to pay attention to the insights and intuitions that come from all currently viable approaches. This is not to say that I am a pluralist about the interpretation of quantum theory. I think there will ultimately be one true way of understanding the theory and think that the division of the theory into its "practical" part and its "interpretation" is a mistake. Nevertheless, until we finally manage to achieve this understanding, we would be wise to keep our minds open, so long as they are not so open that our brains fall out.

Different interpretations quantum theory provide different insights, which are valuable even if the interpretations themselves turn out to be false. For example, the many-worlds interpretation was a key inspiration for the idea of a quantum computer, as proposed by David Deutsch, even though the idea itself does not require that interpretation. Similarly, the tension between de Broglie-Bohm theory and von Neumann's no-go theorem for hidden variables was the main driving force behind Bell's development of his eponymous inequalities. If you like, you can interpret those inequalities in terms of the ability of Alice and Bob to perform better in certain cooperative games using quantum resources than they could with classical resources without ever mentioning hidden variables, as many quantum information theorists are wont to do. However, it is unlikely that Bell's theorem would ever have been discovered were it not for the foundational context in which it first arose.

What I was trying to argue in my article, is that the PBR theorem might have a similar status. Whilst it is inspired by the question of the status of the quantum state in a hidden variable theory, it may end up telling us something new about the differences between quantum and classical resources in general. We will never gain these new insights if we close off avenues for understanding quantum theory, even if we regard the foundational programs that they are associated with as unlikely to succeed in the long run.

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