Two Challenges in Teaching Transport Phenomena

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Transport phenomena is one of the cornerstones of chemical engineering and many other disciplines, since it provides the means to understand many processes at different levels of scale using the language of mathematics. In terms of teaching, classes related to transport phenomena are, most of the time, regarded by students as the hardest ones of their curricula. Transport phenomena classes have long been taught as a combination of theory and laboratory experiments and require that the student thinks about how to reasonably model a given process. Certainly, the use of mathematics is unavoidable and this represents, in my opinion, a serious challenge in teaching transport phenomena: How to make a proper balance between physics and mathematics. This challenge is not new and has been present since early teachings of this subject. The solution to this challenge appears to be the following: use basic mathematics (*i.e.*, ODE) for undergraduates and leave harder stuff (*i.e.*, PDE) for graduate students.

In recent years, computational simulations have made their way into teaching and research on transport phenomena. This remarkable tool is a game-changer but also a double-sided blade that requires cautious use. On one hand, numerical simulations can provide insights that may be hard to measure in the laboratory. On the other hand, it is easy to grant credibility to fancy simulations that may be erroneous. Here, I propose to identify a second challenge: How to balance the use of numerical simulations, laboratory experiments and classroom teaching. Note that the solution adopted to solve this challenge also affects the solution given to the first one. Currently, there is no universal solution to these (and many other) challenges. However, some ideas can be proposed: for example, an integrated approach where the analysis of a problem is carried out using analytical solutions (for a simplified version of the system), numerical solutions (for a more elaborate system realization), and laboratory experiments may be considered. In this process, deficiencies related to problems formulation, use of experimental instruments, analytical and numerical tools, as well as analysis, interpretation, and discussion should be addressed and overcome. This is just a personal proposition and many other alternatives can be pondered. The message to be kept here is that sooner than later changes need to be made to address these challenges and we need to start pondering about possible solutions now. ❐