

## Letters

**Equilibrium: A Teaching/Learning Activity**

In September 1998, Wilson described a useful classroom activity for the study of chemical equilibrium that others have since praised and refined (1–4). I would like to suggest a modification whereby students use classroom clickers to remotely submit answers that can be immediately counted and displayed on a computer. The illustrative power of the activity is not only preserved, but augmented, and time can be saved since there is less to hand out and organize. All that is needed beside the clickers is a coin or die for each student to randomly dictate individual outcomes. The details of the activity are as follows:

1. The entire class participates together and begins by submitting an R or a P for reactants or products, respectively, and the results are displayed on a projected computer image. The teacher has the option of asking all of the students to submit one or the other, or allowing a random sampling as the initial state.
2. At this point the rules to update the present state to the next one are provided. For example, one possible set of rules is that everyone who recently submitted an R must now submit a P, while everyone who submitted a P flips a coin (or rolls a die), and if it is heads they submit P again, otherwise they now submit an R. Each cycle can be completed in seconds with the orchestration of the teacher. (In the absence of clickers, the activity could still be modified as described with the teacher counting raised hands).

Analogous to Wilson's original description, the rates can be altered to demonstrate their relationship to the equilibrium constant and the effects of temperature. Furthermore, several additional aspects can be evidenced:

- Since the entire class works together with each student acting as a molecule, each student gains a window into the chaotic path of an individual molecule in the midst of a dynamic equilibrium.
- A portion of the class can start the activity only after the rest of the class has achieved a dynamic equilibrium, thereby demonstrating Le Châtelier's principle for the addition of reactant or product to a system at equilibrium.
- Finally, since random events contribute to the generation of each new state, there will be some fluctuations even in the steady state, akin to the true nature of chemical equilibria. The size of these perturbations can be shown to depend on the size of the class, and even with classes of 25 or so the activity is very effective.

**Literature Cited**

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