Review of: "Implementing Simulation Software to Develop Virtual Experiments in Undergraduate Chemical Engineering Education"

Víctor Quesada[1]

1 Universidad de Oviedo

Potential competing interests: No potential competing interests to declare.

This article describes the use of simulation software in preparing students for experimental work in chemical engineering. First, a form of virtual laboratory is prepared and tested, using existing open-source and proprietary computer programs. Then, students try the software, perform virtual experiments, and report their opinions on the process. I find the work interesting, with room for improvement, and the manuscript mostly satisfactory, with some caveats discussed below. I think that these results may serve other departments in incorporating virtual laboratories into their teachings. In this regard, proprietary software is a significant hurdle that authors might want to avoid going forward.

Major/general points:

- The manuscript is not easy to follow at some points. Sometimes information is shown out of place or unnecessarily repeated. For instance, section 2 starts with a justification summarizing the introduction, when I would expect a description of the virtual experiments themselves. Then, section 2.3 starts again with a justification for virtual experiments in engineering. I think that restricting these and other justifications to the introduction and discussion would improve the flow of the manuscript.
- The authors should state who ran the simulations and prepared the figures. Ideally, the authors should be the students, but I have not found this information in the text. Related to this, I would ask the authors to describe how much room is left for students to play with the models independently. This, in turn, would open the possibility of using the virtual laboratory in a context of blended learning and/or inverted classrooms.
- The questionnaire leading to the results in figure 15 should be included as supplementary information. Presumably, figure 15 shows some kind of average of the answers to the questionnaire. Information about this averaging measure should be provided, along with some measure of dispersion of the results.

Minor points and opinions:

-At some points in the manuscript, virtual laboratories are pitted against traditional laboratories. In my opinion, virtual laboratories should complement, never replace, physical laboratories. For instance, I find the sentence "[v]irtual labs also hold promise for institutions that have a dearth of resources" misleading. Virtual labs are no substitute for actual laboratories.

-Related to the previous point, several puzzling sentences might be better explained or corrected.

-At the introduction, the manuscript says that "[t]raditional laboratory practices do not have activities to prepare the

student to be a future practicing scientist". I find this expression too broad and probably unfair. The authors should at least explain which skills are not developed in laboratory practices. Ideally, they should also explain how those skills are practiced in virtual laboratories.

-In point 2.2, it is stated that "... inhalation of aromatic compound vapors for a longer duration is a health hazard". If that is the case, that would be a good moment to discuss and apply safety measures, which will be mandatory anyway when students graduate and perform those experiments at work.

-Right afterwards, the manuscript reads "[t]he use of essential oils extracted from plants and fruits is expensive for laboratory demonstration". Unless I am missing something, essential oils can be obtained by steam distillation in any engineering laboratory at a fraction of the cost of acquiring and maintaining a computer. If not, this might warrant a more detailed explanation.

-It would be useful for non-specialists to explain what "v" and "I" mean in figure 2.

-In figure 14, the data would be much easier to follow if points and lines of different colors were used to express and link the percentiles in each group.