Review of: "Integrating Virtual Tools Into the Face-To-Face Teaching of Undergraduate Analytical Chemistry"

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Potential competing interests: No potential competing interests to declare.

Title: Integrating Virtual Tools Into the Face-To-Face Teaching of Undergraduate Analytical Chemistry

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Abstract: The paper discusses the transition from traditional face-to-face instruction to a hybrid education model in analytical chemistry courses at the National University of Luján. It thoroughly examines the benefits and challenges of each instructional modality, highlighting the advantages of integrating virtual and face-to-face components for a comprehensive analytical chemistry education. The study emphasizes that theoretical lessons benefit from a hybrid approach with face-to-face sessions complemented by asynchronous virtual tools, while practical laboratory work remains essential to be conducted face-to-face. The use of simulation software for gas and liquid chromatography equipment is highlighted as a valuable addition to practical learning without extending the required time or additional resources.

Strengths:

1. **Comprehensive Analysis:** The paper provides an extensive evaluation of the benefits and drawbacks of the hybrid education model, effectively explaining the balance between theoretical and practical lessons.
2. **Feedback from Students and Educators:** The study is well-supported by student surveys and educator evaluations, providing concrete data on the effectiveness and efficiency of the educational changes implemented.
3. **Incorporation of Simulation Software:** The use of simulation software for gas and liquid chromatography is highlighted as a significant enhancement, offering students a better understanding of theoretical concepts and more efficient use of laboratory time.

Weaknesses:

1. **General Applicability:** The results are specific to one university and course, and it is uncertain whether the same impact would be observed in other institutions or different disciplines.
2. **Technological Accessibility:** The effectiveness of virtual tools relies heavily on students' access to the necessary technological infrastructure, which might not be uniformly available, potentially leading to equity issues.

Conclusion: Overall, the paper successfully demonstrates that the hybrid education model is an effective method for teaching analytical chemistry. The integration of virtual components for theoretical lessons provides flexibility, while face-

to-face laboratory work is crucial for developing practical skills. The use of gas and liquid chromatography simulation software enhances student motivation and understanding of complex concepts. This study contributes valuable insights into achieving an optimal balance of virtual and face-to-face instruction, offering significant benefits for flexible and effective education.

As a reviewer, I note that the language quality of the manuscript is high, and it adheres to the best practices in the field. This study offers a valuable contribution by highlighting the positive impacts of the hybrid education model in analytical chemistry and is recommended for publication.

Overall Rating: 4.5 out of 5

Note to Authors and Publisher: The study provides important insights into achieving flexibility and effectiveness in education. However, broader applicability could be enhanced by conducting similar studies across different universities and disciplines. Additionally, further evaluation of technological access and equity issues is recommended.