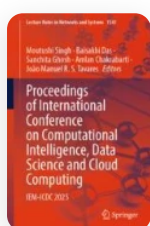


Integration of Virtual Lab to Enhance the Quality of Laboratory Experiments in E-Learning Domain

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Abhishek Sharma , Subhabrata Sengupta, Kajari Sur, Avijit Bose & Rupayan Das

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Abstract

This paper seeks to propose the incorporation of Virtual Labs into e-learning settings environments to improve the quality and deliver of laboratory-based education. Virtual labs use 3D models, AR and interactive tools and provide students with an opportunity to conduct experiments on the Internet as most of the difficulties, connected with the absence of the main reagents or time restrictions, or security issues in real-life labs can

be avoided. Analyzing their effectiveness based on students' activity, achievement and possibility of expanding, the use of digital labs in the context of the future development of science and engineering will help investigate the potential of virtual labs. The results show that virtual labs are an effective and a more cost-effective means to enhance laboratory learning in the times of the Summer Oaks. The prospects for e-learning are staggering especially where virtual labs will provide opportunities to conduct experiments when resources are limited. According to the research done in the present study, the incorporation of virtual labs in e-learning environment can aid in the improvement of the quality of STEM instructional provision, especially concerning the practical rendition of theoretical concepts.

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References

1. Syukri M, Rahmi M, Saminan S, Artika W, Subramaniam TS (2022) Virtual lab based on STEM approach: is it effective to enhance students concept of temperature and

heat?. J Ilm Pendidik Fis Al-Biruni 11(2):151–64

2. Ali N, Ullah S, Khan D (2022) Interactive laboratories for science education: a subjective study and systematic literature review. *Multimodal Technol Interact*. 6(10):85
3. Halim L, Rahman NA, Wahab N, Mohtar LE (2018) Factors influencing interest in STEM careers: an exploratory factor analysis. *Asia-Pac Forum Sci Learn Teach* 19:1–34
4. Elisa AR, Wiratmaja IGP, Nugraha MG, Dantes N (2020) Development of virtual laboratory media in chemistry laboratory learning in the 21st century. *J Phys Conf Ser* 1567(3):032058. <https://doi.org/10.1088/1742-6596/1567/3/032058>
5. Kolil VK, Muthupalani S, Achuthan K (2020) Virtual experimental platforms in chemistry laboratory education and its impact on experimental self-efficacy.
6. Celik C, Guven G, Cakir NK (2020) Integration of mobile augmented reality (MAR) applications into biology laboratory: anatomic structure of the heart. *Res Learn Technol* 28
7. Winkelmann K, Keeney-Kennicutt W, Fowler D, Lazo Macik M, Perez Guarda P, Joan AC (2020) Learning gains and attitudes of students performing chemistry experiments in an immersive virtual world. *Interact Learn Environ* 28(5):620–634. <https://doi.org/10.1080/10494820.2019.1696844>
8. Zhong Y, Liu C (2014) A domain-oriented end-user design environment for generating interactive 3D virtual chemistry experiments. *Multimed Tools Appl* 72(3):2895–2924. <https://doi.org/10.1007/s11042-013-1554-1>

9. Zayas-P´erez B, Cox R (2009) Teaching safety precautions in a laboratory DVE: the effects of information location and interactivity. *Comput Sist* 13(1):96–110.
<https://doi.org/10.13053/cys-13-1-1225>

10. Sampaio P, Mendonça R, Carreira S (2014) Learning chemistry with virtual- labs Uma: a customizable 3D platform for new experimental protocols. *Multimed Tools Appl* 71(3):1129–55. <https://doi.org/10.1007/s11042-012-1260-4>

11. Tarng W. Development and application of a virtual laboratory for synthesizing and analyzing nanogold particles. *J Comput* 2017;12(3):270–83.
<https://doi.org/https://doi.org/10.17706/jcp.12.3.270-283> (Taipei).

12. Lynch T, Ghergulescu I (2017) Review of virtual labs as the emerging technologies for teaching stem subjects. In: *Proceedings of the INTED* 1:6082–91.
<https://doi.org/10.21125/inted.2017.1422>

13. Geng, J, Wu X (2021) Application of virtual reality technology in university education 2021 2nd International Conference on Artificial Intelligence and Education (ICAIE). Dali, China, 472–475. <https://doi.org/10.1109/ICAIE53562.2021.00104>

14. Ambarwati P, Anisa NN, Setiawati A, Ajizah DN, Izzati ZAN, Erika F (2021) The 21st century skills on chemistry learning based on virtual lab in senior high school

15. Wu BJ, Wong SK, Li TW (2019) Virtual titration laboratory experiment with differentiated instruction. *Comput Animat Virtual Worlds* 30(3–4).
<https://doi.org/10.1002/cav.1882>

16. Dunnagan CL, Dannenberg DA, Cuales MP, Earnest AD, Gurnsey RM, Gallardo Williams MT (2019) Production and evaluation of a realistic immersive virtual reality organic chemistry laboratory experience: infrared spectroscopy. J Chem Educ 258–262. <https://doi.org/10.1021/acs.jchemed.9b00705>
17. Chabra J (2020) Using a cooperative hands-on general chemistry laboratory framework for a virtual general chemistry laboratory. Framework for a virtual general chemistry laboratory. J Chem Educ
18. Reeves SM, Crippen KJ (2021) Virtual laboratories in undergraduate science and engineering courses: a Systematic Review. 2009–2019. J Sci Educ Technol 30:16–30. <https://doi.org/10.1007/s10956-020-09866-0>

Author information

Authors and Affiliations

Institute of Engineering and Management, Kolkata, India

Abhishek Sharma, Subhabrata Sengupta, Kajari Sur, Avijit Bose & Rupayan Das

University of Engineering and Management, Kolkata, West Bengal, India

Abhishek Sharma, Subhabrata Sengupta, Kajari Sur, Avijit Bose & Rupayan Das

Corresponding author

Correspondence to [Abhishek Sharma](#).

Editor information

Editors and Affiliations

Information Technology (IT), Computer Science Engineering (CSE) and Allied Branches, Institute of Engineering and Management, Kolkata, West Bengal, India
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