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E-learning resources and virtual labs

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India's recent strides in information technology have propelled the growth of web-based digital learning in most disciplines of science and engineering education. Distance education and open learning endeavours offer many advantages in resource-limited developing countries, where the number of potential learners is much higher than the number of experienced teachers or advanced educational institutes[1].

However, these endeavours alone have proved insufficient in providing practical skills for science experiments or analysis of scientific data. Virtual laboratories, which act as free, round-the-clock replicas of actual laboratories, could be an effective alternative. Learners in a virtual laboratory can understand scientific theories and also experience practical experimental procedures[2,3]. As educational budgets in developing and under-developed countries continue to shrink, e-learning and open-learning programmes are gaining popularity[4].

E-learning proteomics resources

E-learning and virtual labs are rapidly changing the culture of education in developing countries[5]. India is playing an imperative role in the development of diverse e-learning resources and virtual labs in proteomics and other disciplines of biotechnology (see box on right). In recent years, proteomics and related disciplines have been incorporated into academic curricula across the globe due to their increasing impact on clinical and industrial research.

The Indian Institute of Technology Bombay has developed pioneering proteomics learning resources such as the Virtual Proteomics Lab, Clinical Proteomics Remote Triggering Virtual Laboratories, and other related e-learning initiatives supported by India's ministry of human resources and development (MHRD) with a goal to disseminate high-quality educational content exclusively in proteomics[6]. The resource contains modules on gel-based proteomics, mass spectrometry-based proteomics and bioinformatics, each with a set of experiments (http://iitb.vlab.co.in/?sub=41&brch=118). The course contents of Virtual Proteomics Lab have now been incorporated as a tutorial article under the International Proteomics Tutorial Programme (IPTP 14) developed by the Human Proteome Organization (HUPO) and the European Proteomics Association (EuPA)[7].

The Clinical Proteomics Remote Triggering Virtual Laboratory (http://iitb.vlab.co.in/?sub=41&brch=237) creates a realistic virtual environment for learners to get a first-hand experience of performing different proteomic technology experiments commonly used in clinical proteomics research. Additionally, 40 hours of a web-based video lecture course from National Programme on Technology Enhanced Learning (NPTEL) and Open Source Courseware Animations Repository (OSCAR) provides basic working principles and comprehensive details of advanced proteomics technologies using videos, animations and interactive simulations. These new e-learning resources in proteomics serve as valuable global platforms for students and researchers from different disciplines of proteomics.

Virtual labs for rural and urban India

A study of online statistics indicates that virtual lab users have been increasing in India. The study also suggests increasing usage trends in times to come[8].

The researchers tried to figure out the impact and penetration of virtual labs through hands-on workshops in rural South Indian biotechnology and engineering institutes and compared them with

Key biotechnology virtual lab and e-learning initiatives in India

- "Sakshat" Virtual Biotechnology Engineering Labs: http://www.vlab.co.in/
- Technology Enhanced Learning (NPTEL): http://nptel.iitm.ac.in/
- Open Source Courseware Animations Repository (OSCAR): http://oscar.iitb.ac.in/oscarHome.do
- National Knowledge Network (NKN): http://www.nkn.in/
- Amrita Virtual Interactive E-Learning World (A-VIEW): http://aview.in/
- Online Labs for schools: http://www.olabs.co.in/

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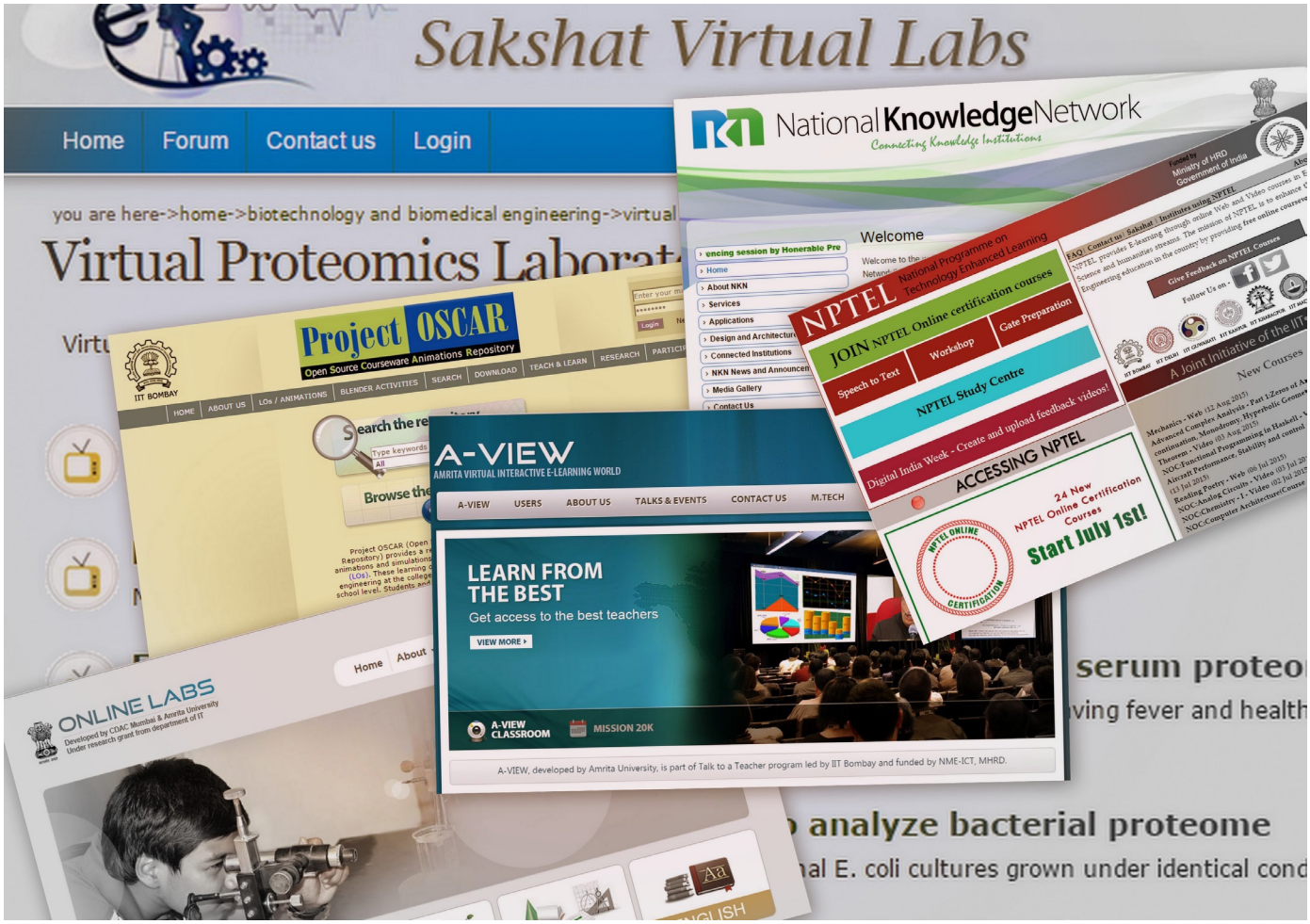

data from urban areas[9]. The feedback showed that 60% of students rated virtual labs as user-friendly tools that made their biotechnology courses interesting and easier to comprehend; 65% found virtual labs to be good online material for better understanding of the basic concepts in biotechnology and about 10% reported difficulty using them due to computer illiteracy or network connectivity issues.

Among 250 teachers surveyed, around 85% suggested that virtual labs could be used as an autonomous, supplementary learning and teaching material for enhancing laboratory education. 67% of the teachers from rural areas adopted virtual labs in their teaching while only 33% from urban areas opted for them.

Virtual labs are a technological innovation providing new learning environments for proteomics and biotechnology users. Simulation-based virtual labs can now train a huge cluster of potential researchers, who could play an important role in bioinformatics analysis of big data sets generated by scientific research labs across the world and effectively accelerate high-throughput translational research.

Virtual and open learning initiatives are poised to bring a dramatic change in science education but cannot completely substitute existing educational institutes or hands-on practical laboratory courses. Effective expansion of science education is possible by taking benefits of the affordances of both the approaches[10]. Innovative and forward-looking initiatives for distributed learning practices through e-learning and virtual labs would certainly enrich the global community of students, scientists and citizens.

References

1. Waldrop, M. M. Online learning: Campus 2.0. *Nature* **495**, 160-163 (2013).
2. Huang, C. Virtual labs: E-learning for tomorrow. *PLoS Biol.* **2**, e157 (2004).
3. Nilsson, T. Virtual laboratories in the life sciences. A new blueprint for reorganizing research at the European level. *EMBO Rep.* **4**, 914-916 (2003).
4. Normile, D. Online science is a stretch for Asia. *Science* **293**, 1623 (2001).
5. Srivastava, S. *et al.* Online education: E-learning booster in developing world. *Nature* **501**, 316 (2013).
6. Ray, S. *et al.* Sakshat Labs: India's virtual proteomics initiative. *PLoS Biol.* **10**, e1001353 (2012).
7. Ray, S. *et al.* Virtual labs in proteomics: New E-Learning tools. *J. Proteomics.* **75**, 2515-2525 (2012).
8. Raman, R. *et al.* The VLAB OER Experience: Modeling potential-adopter student acceptance, *IEEE Education* **57**, 235-241 (2014) doi: 10.1109/TE.2013.2294152 (2015).
9. Diwakar, S. *et al.* Complementing neurophysiology education for developing countries via cost-effective virtual labs: Case studies and classroom scenarios. *J. Undergrad. Neurosci. Educ.* **12**, A130-A139 (2014).
10. de Jong, T. *et al.* Physical and virtual laboratories in science and engineering education. *Science* **340**, 305-308 (2013).