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Review Article

Innovative Practices in Chemical Engineering Teaching - a Brief Review

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ABSTRACT

The chemical engineer has to deal with various interdisciplinary subjects such as mechanical engineering, environmental engineering, biotechnology etc. Many important subjects such as mass transfer, heat transfer, process engineering and fluid flow operations involve time consuming and rigorous computations. The equations in heat and material balance, sand transport phenomena in non-stationary conditions are mostly having non analytical solutions. Also many experimental methods can be made more interesting and easy to understand by using innovative and different teaching methods. Software like MATLAB, virtual laboratory can be a great help in understanding the chemical engineering concepts.

Key words: Software, simulation, parameters, design, virtual labs, experimental design.

INTRODUCTION

Chemical engineering education needs to involve various innovative practices and methods in order to make it more interesting. The chemical engineer has to deal with various interdisciplinary subjects such as mechanical engineering, environmental engineering and biotechnology. Many important subjects such as mass transfer, heat transfer, process engineering and fluid flow operations involve time consuming and rigorous computations. Also many experimental methods can be made more interesting and easy to understand using innovative and different teaching methods. Software like MATLAB, virtual laboratory can be great help in understanding the chemical engineering concepts. Web-lab is a very useful tool to give students training in working with experimental equipment. The current review focuses on innovative ideas and experimentation in chemical engineering education.

INNOVATIVE PRACTICES IN CHEMICAL ENGINEERING TEACHING

Rasteiro et.al. presented a virtual platform to teach chemical processes. [1] According to them, this aspect helps to provide a practical approach to the subjects. They organized the platform into five sections namely separations and unit operations, reaction engineering, process systems engineering, biological processes and virtual experiments. In the first four sections, they demonstrated the effect of various parameters on the processes. In the fifth section they explained laboratory experiment and monitoring related to the four sections. Garcia et.al. studied experimental design in chemical engineering by using MATLAB. [2] According to their studies the equations in heat and material balance sand transport phenomena in non-stationary conditions are mostly having non analytical solutions. Their studies indicated that MATLAB is very powerful tool for solving the chemical engineering problems. They combined a

laboratory rig with a computer-aided solution using MATLAB and Simulink for developing a new laboratory experiment for third-year students. Their experiments included three gas-solid fluidized baths. By using these tools they addressed the problem of the lack of fluidization experiments. Koretsky et.al. carried investigation on a virtual laboratory for enhancement of student learning in experimental design. [3] In their studies, they described the aspects such as the instructional design, implementation, and assessment of a virtual laboratory based on a numerical simulation of a chemical vapor deposition (CVD) process, the virtual CVD laboratory. They used fundamental principles of mass transfer and chemical reaction for the simulation of the reactor. Their studies were intended to complement the physical laboratories. They concluded that students perceived the virtual CVD laboratory as the most effective learning medium used. Ollis and Lamb discussed modern lab experiments for chemical engineering. [4] The new experiments which they introduced covered topics not routinely covered in traditional chemical engineering laboratories. According to studies carried out by Bolf et.al., cybernetic model of a system for process control teaching for chemical engineering students forms a basis for development of intelligent tutoring system. [5] The method development included mathematical modeling and system identification, traditional methods of process control, fuzzy and neural network-based process control and development of knowledge base and computer aided instructions using Tex Sys. They concluded that the students were able to acquire and test their knowledge individually.

Selmer et.al. reported use of web-labs to teach undergraduate chemical engineers. [6] They found that it was a very useful tool to give students training in working with experimental equipment. These tools provided means to share an experiment between different institutions. According to them web-labs also stimulated transferable skills such as teamwork, communication and presentation. Domingues et.al. described the design and implementation of two virtual labs for biochemical engineering education. [7] They divided the studies into five areas namely theory fundamentals, experimental, methodology, calculation methodology, references and laboratory. Replacement of hands on experiments by virtual lab has advantages such as reduced costs, reduced experiment time, improved data with no loss of education efficiency. Wang et.al. emphasized the importance of building chemical engineering simulation with experimental teaching center platform. [8] An interesting investigation on effect of personality type on personality of chemical engineering students and their attitude was carried out by Felder et.al. [9] Active and cooperative learning and inductive presentation methods were used by them. According to Minerick and Schulz, a freshman introduction to chemical engineering seminar course is highly helpful for undergraduate curriculum. [10] The important advantage of their methodology includes their independence from the availability of lab space. Bequette et.al. investigated a studio based learning of process control experiments. [11] They manipulated three inputs namely freshwater flow rate, concentrated salt solution flow rate and heater power for regulating three variables namely three measured process variables level, temperature and conductivity at desired set point values. Silverstein proposed an inductive approach to teaching chemical engineering courses. [12] According to him, this approach may help to have better understanding of mass transfer and stoichiometry. Keith et.al. proposed some new innovative ideas for chemical engineer educators. [13] They discussed some best practices for teaching courses like solution thermodynamics, heat and mass transfer, kinetics and reactor design, process control. Zhong studied scientific thinking methods for teaching of inorganic and analytical chemistry. [14] He

described importance of the scientific thinking methods in the college classroom teaching. In their paper, Young et.al. described a strategy used to improve the learning process of a senior level undergraduate chemical engineering unit operations laboratory course. [15] In their studies, they asked the students to carry out the experiments and analyze the performance characteristics of a particular unit operation and associated equipment.

CONCLUSION

The equations in heat and material balance sand transport phenomena in non-stationary conditions are mostly having non analytical solutions. MATLAB is very powerful tool for solving the chemical engineering problems. Web-lab is a very useful tool to give students training in working with experimental equipment. Many experimental methods can be made more interesting and easy to understand using innovative and different teaching methods. The scientific thinking methods in the college classroom teaching need to be exploited more for better understanding and systematic studies on chemical engineering concepts.

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