World Academy of Science, Engineering and Technology
International Journal of Chemical and Materials Engineering
Vol:17, No:04, 2023

ReactorDesign App: An Interactive Software for Self-Directed Explorative Learning

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Abstract : The subject of reactor design, dealing with the transformation of chemical feedstocks into more valuable products, constitutes the central idea of chemical engineering. Despite its importance, the way it is taught to chemical engineering undergraduates has stayed virtually the same over the past several decades, even as the chemical industry increasingly leans towards the use of software for the design and daily monitoring of chemical plants. As such, there has been a widening learning gap as chemical engineering graduates transition from university to the industry since they are not exposed to effective platforms that relate the fundamental concepts taught during lectures to industrial applications. While the success of technology enhanced learning (TEL) has been demonstrated in various chemical engineering subjects, TELs in the teaching of reactor design appears to focus on the simulation of reactor processes, as opposed to arguably more important ideas such as the selection and optimization of reactor configuration for different types of reactions. This presents an opportunity for us to utilize the readily available easy-to-use MATLAB App platform to create an educational tool to aid the learning of fundamental concepts of reactor design and to link these concepts to the industrial context. Here, interactive software for the learning of reactor design has been developed to narrow the learning gap experienced by chemical engineering undergraduates. Dubbed the ReactorDesign App, it enables students to design reactors involving complex design equations for industrial applications without being overly focused on the tedious mathematical steps. With the aid of extensive visualization features, the concepts covered during lectures are explicitly utilized, allowing students to understand how these fundamental concepts are applied in the industrial context and equipping them for their careers. In addition, the software leverages the easily accessible MATLAB App platform to encourage self-directed learning. It is useful for reinforcing concepts taught, complementing homework assignments, and aiding exam revision. Accordingly, students are able to identify any lapses in understanding and clarify them accordingly. In terms of the topics covered, the app incorporates the design of different types of isothermal and non-isothermal reactors, in line with the lecture content and industrial relevance. The main features include the design of single reactors, such as batch reactors (BR), continuously stirred tank reactors (CSTR), plug flow reactors (PFR), and recycle reactors (RR), as well as multiple reactors consisting of any combination of ideal reactors. A version of the app, together with some guiding questions to aid explorative learning, was released to the undergraduates taking the reactor design module. A survey was conducted to assess its effectiveness, and an overwhelmingly positive response was received, with 89% of the respondents agreeing or strongly agreeing that the app has “helped [them] with understanding the unit” and 87% of the respondents agreeing or strongly agreeing that the app “offers learning flexibility”, compared to the conventional lecture-tutorial learning framework. In conclusion, the interactive ReactorDesign App has been developed to encourage self-directed explorative learning of the subject and demonstrate the industrial applications of the taught design concepts.

Keywords : explorative learning, reactor design, self-directed learning, technology enhanced learning
Conference Title : ICCEE 2023 : International Conference on Chemical Engineering Education
Conference Location : Cape Town, South Africa
Conference Dates : April 13-14, 2023