

Chapter 15

Design of Experiments in Engineering Education: Opportunities and Challenges

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ABSTRACT

The chapter will start with an overview of today's challenges of engineering education. DOE can be very effective for solving problems in view of the new pedagogical challenges in engineering education. The chapter reviews the progress of DOE in engineering teaching and learning for problem solving and for product/process optimization with focus on engineering education in this new millennium. The goal is to identify the main engineering areas accounting for the use of statistical experimental design in engineering education as well as the main teaching/learning strategies and the combination of other tools used to support the use of DOE in engineering education. The main contribution will be to bring up ideas from studies of DOE in teaching/learning engineering environments to better understand the deficit of utilization of such type of approaches in academic projects/experiments despite the common utilization of DOE in statistics and quality literature.

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INTRODUCTION

Engineering students must develop skills with the aim of designing new and improved products and operating maintaining and optimizing industrial processes that are economically viable, valuable to society and with reduced negative environmental impacts. Due to the pressure to market that is nowadays an important issue the engineers must be able to develop better products in half the time. They need to understand the design and operation of processes, how changes in operations and in the environment will affect outcomes, and the actions needed to improve process performance and increase sustainability. The knowledge about the products and processes in engineering and related scientific fields is derived from experimentation mainly in situations where no scientific theory or principles are directly applicable. The Design of Experiments (DOE) methodology can become tremendously important in such circumstances to develop/improve new products/processes in an efficient way. DOE can be very effective for solving general or specific problems and is able to have into account the new pedagogical challenges in engineering education because a structured methodology will have the advantage of helping students to avoid the error of leaping to problem solve without a clear understanding of the problem.

This chapter starts by presenting an overview of the today's challenges concerning engineering education. The speed of changes in engineering practices nowadays also require huge efforts in engineering education practice reason why this change demand a pedagogical paradigm where teaching and learning is student centred.

An overview of DOE is also presented in this chapter with a brief historical analysis of the important developments in DOE being restricted to that of a group of techniques in design that boost the exploration of a region of design variables in one or more response variables. This chapter also presents a literature review regarding the utilization of DOE in engineering teaching and learning for general problem solving as well as for the optimization of product/process with special focus on engineering education. The main objective of the literature review is to identify the main scientific engineering areas that contribute to the use of statistical experimental design in engineering education as well as the main teaching /learning strategies and the combination of DOE with other tools (e.g. simulation, virtual laboratories) used to support the use of DOE in engineering education.

The main contribution of the chapter will be to bring up ideas from those studies devoted to the use of DOE in teaching and learning engineering environments to better understand the deficit of utilization of such type of approaches in academic projects/experiments regardless of the common utilization of DOE in statistics and quality literature. Despite the statistical experimental design finds applications in several engineering areas (e.g. chemical industry, food industry, pharmaceutical research, environmental engineering) limited material have been published concerning the utilization of DOE in engineering education and the challenges for educators and students alike. It is crucial to understand the use of DOE in engineering education and to understand how to improve its use in industrial contexts and in academic and research projects. This work is intended to encourage further discussion between educators, practitioners, and experts in order to find ways to promote the usage of DOE methodology by future engineering graduates and researchers.

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