

CHAPTER SIX

TEACHING AND LEARNING

WITH K. EDSTRÖM, D. SODERHOLM, AND M. KNUTSON WEDEL

INTRODUCTION

This chapter broadens and concludes the discussion of the second question central to the reform of engineering education: *How can we do better at ensuring that students learn these skills?* The curriculum design process, presented in Chapter Four, develops an approach to integrating learning outcomes into the curriculum. Design-implement projects, discussed in Chapter Five, are a principal mechanism to create dual-impact learning experiences, and therefore, both fulfill the skills learning outcomes and deepen students' understanding of disciplinary knowledge.

In this chapter, we explore a wider repertoire of teaching and learning methods that are effective in integrating skills with disciplinary knowledge. We start by describing the engineering students' learning experiences, as seen from their perspectives. Then we describe how the skills learning outcomes can be realized through teaching and learning activities. In this chapter, we emphasize the alignment of teaching-learning approaches with curriculum.

Integrated learning means that students practice and learn personal and interpersonal skills, and product, process and system building skills, simultaneously with disciplinary knowledge. While Chapter Four emphasizes a systematic plan to integrate skills into an integrated curriculum; integrated learning focuses on the implementation of that plan in each of the program's courses and co-curricular activities. Design-implement experiences are good examples of integrated learning, but integrated learning is not limited to project-based courses. Integrated learning is an example of active and experiential learning methods that can be applied in a wide variety of disciplinary settings.

Integrated learning experiences and active and experiential learning are fundamental to reaching the educational goals of a CDIO program. The key attributes of these approaches are that

- Planning for integrated learning requires clear specification of intended outcomes related to personal and interpersonal skills, and product, process, and system building skills, as well as disciplinary content.

- Integrated learning places the engineering teacher at the center of student learning of both the technical discipline and skills, and emphasizes the value and linkages of both parts of the education.
- Experiential learning engages students in situations that engineers will encounter in their profession, and includes not only design-implement projects, but also case studies, simulations, and role playing.
- Active learning, which engages students in manipulating, applying, and evaluating ideas, can be applied not only in experiential situations, but also in traditional disciplinary courses and larger class settings.

Studies indicate that students are more likely to achieve intended outcomes and are more satisfied with their education when they are engaged in these kind of learning methods.

This chapter begins by reviewing the results of studies, conducted in CDIO programs, which summarize students' perspectives on their learning. It then outlines an approach to creating active and experiential learning that builds on the curriculum design process. Examples of active and experiential learning illustrate how skills can be integrated into lecture-based courses and design-implement projects. Finally, some key challenges to effective teaching and learning are addressed, including the need for support to enhance faculty competence in teaching and learning. This challenge is addressed again in Chapter Eight.

CHAPTER OBJECTIVES

This chapter is designed so that you will be able to

- appreciate the importance of student perspectives on teaching and learning
- explain the benefits and challenges of integrating skills with engineering disciplinary knowledge outcomes
- describe methods and resources that promote integrated learning
- recognize the importance of aligning curriculum, teaching and learning, and assessment
- give examples of active and experiential learning methods that foster deep understanding of disciplinary knowledge and acquisition of personal and interpersonal skills, and product, process, and system building skills
- appreciate differences in student learning preferences and learning styles

STUDENT PERSPECTIVES ON TEACHING AND LEARNING

Adapting and implementing the CDIO approach in a university engineering program calls for evolving approaches to teaching, learning, and assessment. In the planning stages, it is helpful to get input from students on their experiences with existing learning methods. For example, student representatives at