13. THE ROLE OF ENGINEERS IN PRE-UNIVERSITY EDUCATION

Success-Factors and Challenges

1. INTRODUCTION

In this chapter we will discuss the role of engineers in pre-university education. To do so, we seek the answers to four questions.

• What value can be added to pre-university education when engineer gets involved?
• Why would engineers want to get involved?
• What are the challenges regarding the involvement of engineers in pre-university education?
• What would be possible solutions?

To answer these questions, we will discuss relevant literature and use examples from research and experience. All examples are set within secondary education in the Dutch educational system. In this system, there are three levels of education: pre-vocational (four years), general (five years) and pre-university (6 years). Most children enter their secondary education in one of these levels and graduate from that level as well. In the given examples, the level and year of the pupils participating will be briefly explained.

2. VALUE ADDED TO PRE-UNIVERSITY EDUCATION WHEN ENGINEERS GET INVOLVED

In general, one could say there are two ways in which engineers can be involved in pre-university education. The first is to offer pupils the opportunity to work alongside professionals in a company or institution in the form of an apprenticeship. Second, engineers can be involved in classroom activities within the school-setting. In these programs, the involvement may either be incidental or structural and take place at school or at the working venue of the engineer. Apprenticeships mostly involve individual pupils, whereas in classroom-activities pupils are more often involved as a group.

There are several merits that can follow the involvement of engineers in pre-university education. First of all, the engineer can add a professional or authentic
context for textbook concepts. Dutch pupils in secondary school are offered physics, biology, and chemistry, but the interdisciplinary nature of the work of an engineer cannot be fully dealt with in separate school-subjects. Although in a recent renewal of the programs for these subjects more practical contexts were added for these subjects, concepts are still divided into disciplinary subdomains, such as mechanics, electricity, and magnetics (Vries, 2012). Having an engineer explain about his or her daily work can show pupils how theoretical concepts are put into practice. Indeed, Braund and Reiss (2006) describe how out-of-school contexts contribute to pupils’ learning in science and technology.

Results for increased conceptual understanding of science and technology are not the same in all reported activities and may depend on the type of involvement and the activities undertaken between engineers and pupils. Bleicher (1996) for instance finds limited growth of conceptual understanding, more limited than developers had intended.

On the other hand: Ritchie and Rigano (1996) report pupils gaining a sophisticated chemistry knowledge by participating in an apprenticeship programme. The authors suggest that time and being fully immersed in the culture of their laboratory caused this.

Literature also suggests that the interaction between pupils and engineers challenges pupils more than regular technology education in school, or ‘school science’. This is especially true in situations where engineers and pre-university pupils work together. This can either be in the form of an apprenticeship or in a project where the engineer’s function is that of a mentor or mandator. As Cobb (1994) and Greeno, Moore et al. (1993) describe, school science and technology can be perceived by pupil as only applying within the boundaries of the formal environment in which it is told: the classroom. Learning in an authentic context, with an engineer as a mentor, challenges pupils to apply knowledge to ‘real’ problems. Abraham (2002) for instance showed that working together with an engineer resulted in an increased self-reported gain of knowledge among the pre-university pupils involved.

An example of a project where pre-university pupils work together with engineers is the Imagine competition, founded by the Delft University of Technology. In this competition engineers formulate proposals for possible use of technology based on their own work and pre-university pupils further design the application of that technology for a developing country. A qualitative study by (Masson, Klop, & Osseweijer, 2014) used the *expectancy-value model of achievement related choice* (Eccles & Wigfield, 2002) to analyse factors in the pupils’ motivation to participate in the Imagine competition. The study found that interest-enjoyment values and attainment values were most important in the pupils’ motivation to participate in the Imagine competition. In this specific activity these values were linked to the fact that the pupils were working on ‘real’ problems instead of text-book exercises and that they felt that by working on these problems together with professionals they could contribute to improving people’s live in developing countries. Pupils reported that they were motivated more by this project than they are by their regular school work.