Chapter 16
Methodologies for Engineering Learning and Teaching (MELT):
An Overview of Engineering Education in Europe and a Novel Concept for Young Students

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ABSTRACT

The concept of Smart City comprises many levels of development, quality of life and wellbeing. One of the key aspects of this idea is the relevance of the overall education of citizens, on technical competences as well as responsible citizenship. Within the innovation-focused drive to future cities, scientific literacy is paramount, particularly considering engineering education. This is noteworthy for the education of today's students, preparing them for life in tomorrow's multifaceted technology-driven world, and directing them to personal and professional development within scientific careers. This Chapter describes the challenges and opportunities of education within today's society paradigms, with an eye on the Smart Cities of the future. A new, innovative and connected approach is presented, with concepts that encompass the main stakeholders in the scientific education system along with the main actors in society. A global and scalable education framework model is detailed, aiming to provide guidelines for an improved collaborative approach to STEM education in the future.

INTRODUCTION

STEM (*Science, Technology, Engineering, Mathematics*) careers are essential for the 21st century innovation and competitiveness in Europe as a pillar of the *Smart City* concept. Even so, there is still a gap between this reality and the expectations and intentions of Upper Secondary School students in pursuing a STEM career (Sjoberg & Scheiner, 2010). As confirmed by different international reports, Europe is facing a serious decrease in young people's motivation for STEM-related studies and careers. One of the factors that may contribute to this lack of attractiveness of students to these fields may be the way science is taught in schools (Osborne et al., 2003).

It is within this ecosystem, transversally present and properly identified in Europe, that the MELT approach was idealized. In a nutshell, the main objectives of MELT are:

1. To provide the effective opportunity to listen and to give voice to all involved stakeholders in engineering education, by creating a forum for "face to face" debates, critical reflections and analysis, bringing together students and teachers of different education levels, as well as science and industry professionals, leading to an *Education Parliament model* (EduP);
2. The development and validation of a novel *Expectation Alignment index* (EAi), objectively measuring the level of alignment of expectations between the involved stakeholders regarding STEM education and career pathways (in particular, mechanical engineering paths);
3. The promotion of a *STEM Education Framework* (STEM-EF), increasing the awareness of high school students to the scope, options, challenges and advantages of considering a Higher Education future path and more specifically a STEM career, once again particularly focused on engineering courses.

These methodologies are set into the reality of engineering teaching and learning strategies at the European level, in a fully scalable and reproducible way, towards a Global Engineering Knowledge culture. The present Chapter is devoted to present the details and evolution of the implementation of MELT methodologies, starting from local, regional or national propositions, towards a scalable model prone to be applied at the European level and, therefore, to be a contribution to the development of the Smart City concept. It is also related to a detailed description of relevant examples of teaching/learning methodologies already in place in Europe, namely of their main features and objectives. Particular emphasis is given to their impact towards a more inclusive Higher Education system, truly linked to High School students, from one end, and to industry/science stakeholders, to the other.

BACKGROUND

The *Smart City* concept is related, among other things, to the broad idea of people living in a better world. The concept aims to improve the interconnection between citizens, with governments paying a special focus on creating and redefining new environments for the education of today's students, preparing them for life in tomorrow's multifaceted technology-driven world (Klett & Wang, 2014).

Various definitions that evolved from Digital City to Smart City (and more recently to Smart City of the Future) made it clear that technology and infrastructures are prominent aspects of the Smart City concept. However, the concept embraces not only various definitions but also diverse directions, repre-

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