

**Framework Programme 7**  
**Capacities: Collaborative Project**  
**Project no. 230376**  
**SIS8-CT-2009-230376**

**Contract start date: April 1st 2009**  
**Duration: 30 months**



**HELENA**  
Higher Education Leading to  
ENgineering And scientific careers

---

***Deliverable D2.3***  
***State of the Art: Curriculum Research in Engineering***

---



## COPYRIGHT

© Copyright the HELENA Consortium.

The HELENA Consortium comprises:

Siauliu Universitetas	Co-ordinator	Lithuania
Fundacion Labein	Contractor	Spain
Ecole Normale Superieure De Cachan	Contractor	France
Universitaet Klagenfurt	Contractor	Austria
Loughborough University	Contractor	United Kingdom
Institut Mihajlo Pupin	Contractor	Serbia
Egalite des Chances dans les Etudes et la Profession d'Ingenieur en Europe Asociacion	Contractor	France

This document may not be copied, reproduced, or modified in whole or in part for any purpose without written permission from the HELENA Consortium. In addition to such written permission to copy, reproduce, or modify this document in whole or part, an acknowledgement of the authors of the document and all applicable portions of the copyright notice must be clearly referenced.

All rights reserved.



## Executive Summary

---

This deliverable outlines work completed under Task 2.3 State of the Art Review of Curriculum Research in Engineering & Technologies in higher education by each partner country. Deliverable 2.3 consists of three parts. It provides information about existing research and statistics addressing curriculum issues in engineering HE in EU, including the demands for changes in engineering education and curriculum development, from gender perspectives, with special focus on interdisciplinary and innovative learning and teaching (section 2). Section 3 includes a review of Curriculum Research in Engineering in HELENA partner countries and research that explores research discussion of the framing of curriculum development – in gendered or non-gendered terms and how curriculum can be couched in technological-economic, technological-social, technological-humanitarian, innovative terms in HELENA project countries. Country reports from six different cultures have produced a large amount of interesting data and although these are too detailed to include in the main report, we have included these in the appendices should further information be required.

From the Engineering Curriculum Research in EU before this project were mentioned main findings during last 15 years:

Universities are exploring ways to revise the *engineering curriculum* in order to meet the changing needs of industry and society. Any restructuring of an engineering curriculum must take into account the correlation between society, engineering competencies and the changing paradigm of engineering education. The 'employability' of graduates depends on a combination of high technical knowledge, practical experience and soft skills. Decreasing student enrolment figures in engineering in many countries call for appropriate measures to be implemented including the development of attractive programmes of study and challenging learning environments.

Over the last decade there have been many initiatives in the European Union and other countries to encourage girls to become engineers. Reviewed literature has shown that females have more negative attitudes toward *engineering* and technology than do males. Despite greater equality in access to higher education and employment women's participation in engineering careers does not reflect this. Higher education engineering curriculum is male based. In construction of engineering curriculum three aspects have been neglected: 1) students background in the light of formal and informal experience and interests, 2) student/student interactions, 3) teacher/student interaction. Innovation of the curriculum with regards to gender mainstreaming means broadly oriented integrated and content rich teaching material, diversity in teaching and learning methods.

As an academic discipline, engineering is continuously undergoing a process of rapid expansion and diversification that is now significantly characterized by interdisciplinary approaches. There is a rise of interest in increasing interdisciplinary studies. As a profession, engineering has to deal with scientific and technological matters, but



increasingly economic, political, ethical, societal and environmental aspects are taken into account as well.

Society places many demands on an engineer; to be technicians with a human side, be adept in interdisciplinary skills that include both technical and non-technical competencies that enable them to critically analyze, solve problems, communicate effectively, and be able to learn continuously as the workplace changes. Introducing social science and other disciplines into engineering could, ideally, help bridge the rift that exists between producers and consumers of technology. Social sciences, humanities, cultural and management studies are also as important as the traditional applied sciences for the portfolio of engineering competencies because students need to understand the financial, business, environmental, economic and social constraints in which engineers operate. Most of the studies and projects showed that interdisciplinary curriculum is one of the central elements for fighting against gender and engineering stereotypes.

Reviewing literature of engineering education and curriculum, learning and teaching methods we have found that many studies have been presented in the last decade. Past studies have shown that a change in learning environments and the methods by which learning takes place might increase number of female choosing engineering carriers. Supported by the experience of the Scandinavian, the United Kingdom and other EU countries more and more higher technical education institutes are introducing new forms of education, such as problem-based and project based education, which increases the appeal of technical education and have a positive effect on the intake, retention and output of students. Surveys and reports undertaken to document and evaluate active teaching and learning methods indicate that project and problem based learning can satisfy the demands for required knowledge, skills and attitudes of engineering graduates. But active and experiential learning is not limited only to project orientation and problem based learning. It should also use ICT environments, various extra curriculum activities and more traditional forms like labs, exercises and design activities.

However, changing teaching methods and didactical design of engineering courses are steps in the right direction but not sufficient for making education gender inclusive. Changes must be made also in content, followed by redesign of existing and design of new courses. Broadening and the repositioning of the curriculum is the challenge facing technical education for the next few years. From the perspective of larger participation of girls, the exploration of the boundaries of technology is especially interesting. Integrating more real-world concerns can also potentially reverse the declining interest in engineering.

Reviewing the Curriculum Research findings in E&T area HELENA project partners from 6 countries - Austria, France, Spain, Serbia, UK and Lithuania from the States of the Art Reviewing of Curriculum Research in E & T in Higher Education are as follows:

- *Description of pre-existing conditions* (Bologna reform impacts: standardised degree levels across Europe, more transferable and standardised; course content proscription by the professional bodies that accredit courses);



- *Interdisciplinary approach to E&T courses.* The interdisciplinary, multidisciplinary, or holistic approaches in engineering courses are a positive step and curricular transformations and research is moving towards innovations. Engineering education is adopting multi-disciplinary approaches and more innovative teaching and learning methods are applied, but these are mostly developed without gender-mainstreaming in mind.
- *Curriculum content in E&T with focus on gender.* Rapid content development asks for new teaching techniques, and this in turn requires knowledge from non-engineering disciplines, engineering programmes may become more attractive for female students. The need to make the engineering curricula more socially relevant is universally recognized.
- *Teaching techniques and demanded skill system.* Alongside the developments in course content teaching environment and assessment innovations are in use. A focus on skills may be interpreted as representing a broadening of the remit of university education and at the same time a broadening of the term skill to include aspects of knowledge and theory.
- *Projects leading to curricula innovations.* Projects are an approach to non-traditional educational schemes for engineering students and teachers. As study programmes are mostly bound with output standards that make adding optional, interdisciplinary modules to existing programmes difficult, the gender-inclusive teaching and learning methods are successfully implemented through project work.
- *Market requirements and employers' needs, marketing of E&T courses.* Innovations are mostly focused on making engineering more relevant to industry and to students themselves. Scientists as well as employers underline that there is demand for engineers who can work "outside the boundaries of their own disciplines". Engineering curriculum development and research are not usually framed within gender mainstreaming debates and rather focus upon economic and technological imperatives. As the main task is to make up curriculum to fit labour market needs, gender is just not the most important in developments in engineering curriculum during a period of widespread innovation and progress, which in itself offers a good opportunity to embed gender inclusive measures.
- *The research on traditional and non-traditional engineering study programmes, good practice in engineering education.* Only some studies have taken a gendered view of engineering curriculum developments, others have not addressed this issue at all. Generally the developments of engineering study programmes are under investigation but not in a gender dimension. The reasons for this are not clear. It may well be that the best way to develop engineering curriculum in a more inclusive vein is by the 'backdoor', as more overt attempts to address women's' position in the technical and scientific fields may be viewed as counterproductive.



In most countries few experiences and not much research have been done in relation to the impact of curricula development in engineering, neither on gender impact assessment of curriculum content.

It is evident that further research is needed to address how new, innovative teaching techniques and practices, and curriculum development impact on students and whether there is societal and gender differences concerning these initiative.

This deliverable will also inform WP4 and WP5, as well as T3.4.



### **Acknowledgement**

The HELENA project (SIS8-CT-2009-230376) is co-funded by the European Commission, through its seventh Framework Programme (FP7) under 'Capacities'.

The authors wish to acknowledge the Commission for their support of the project, the efforts of the partners and the contributions of all those involved in HELENA.