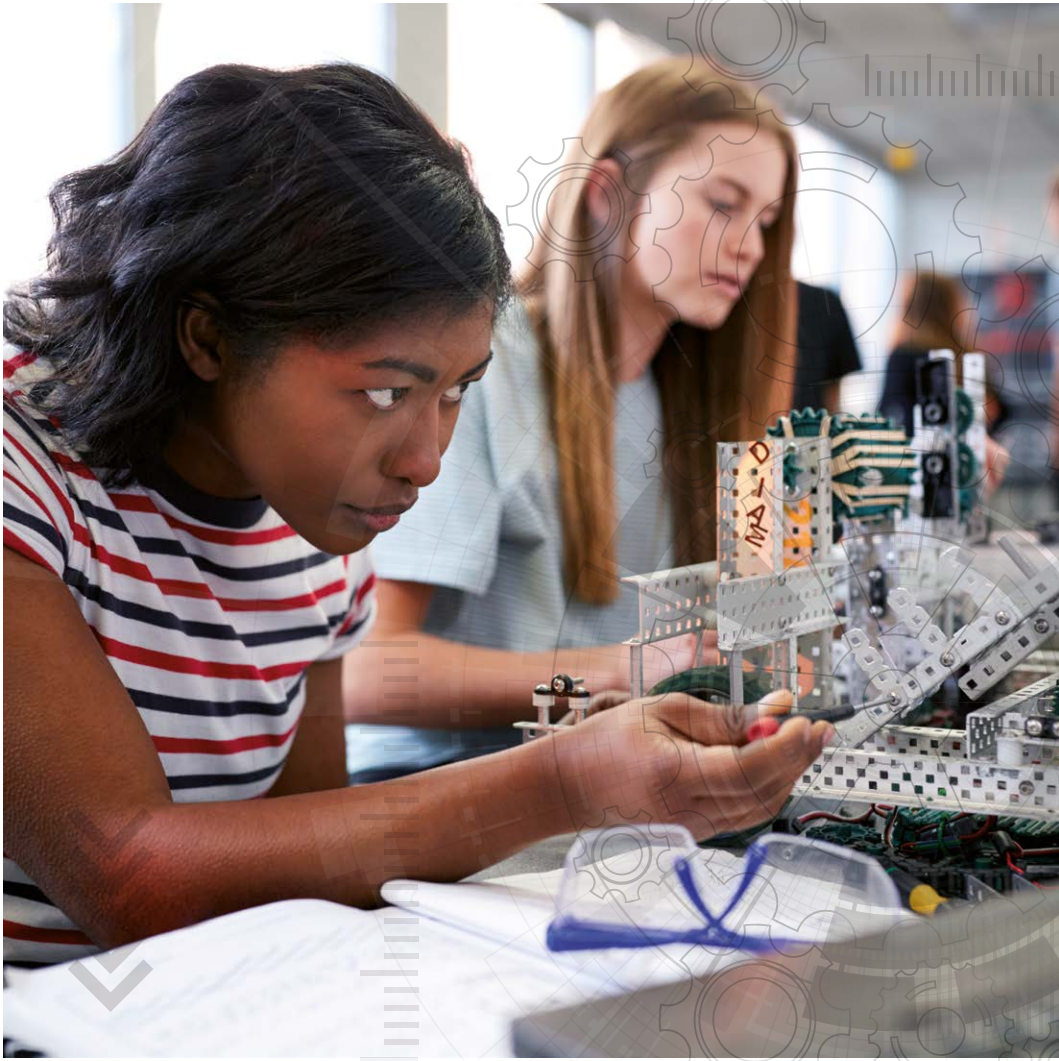
enhance

The ENHANCE Taxonomy of Professional Attributes

Creating curricula that produce creative, community-focused, professional engineers



www.warwick.ac.uk/enhance

INTRODUCTION

When designing engineering curricula, the aim of meeting market, industry and societal needs should be central.

Developing curricula which integrate markets, industry and communities within the Higher Education Framework creates its own specific challenges and opportunities.

Optimal curriculum design aims at delivering attributes (knowledge, skills, behaviours) needed for industry, market, government and tackling grand challenges.

The ENHANCE taxonomy aims to demonstrate how these needs can be met through the application of state-of-the-art education approaches.

THE ENHANCE PROJECT SURVEY EXPLORED THE FOLLOWING QUESTIONS:

- To what extent engineering curricula offered by the Partner HEIs and around the world reflect industrial, community, national and global engineering needs;
- What are the challenges faced in integrating industrial, community, national and global engineering needs in engineering education;
- What are the current practices among the Partner HEIs and around the world in delivering graduate engineering education (undergraduate and postgraduate);
- What are the emerging teaching and learning activities and assessment methods;
- What is the contribution of industry in the delivery of engineering education;
- What are the implications of Quality Assurance requirements in the development of engineering curricula;

Over 700 respondents from Higher Education, Industry and Quality Assurance Agencies took part. The outputs of the survey contributed to establishing a taxonomy of attributes to be developed in graduate engineers for tackling complex contemporary engineering problems such as humanitarian challenges with reference to how these relate to disciplinary and interdisciplinary knowledge, skills and behaviours, and how these align to industry/market needs and government/quality assurance requirements.

TAXONOMY

STAKEHOLDERS	ATTRIBUTES			THREADS		ENABLERS		ASSESSMENT METHODS	
Industry Quality Assurance Agencies Higher Education Institutions	ENHANCE Attributes	Knowledge	Realistic applications	ENHANCE Threads	Professionalism and practice	ENHANCE Enablers	Internships and industry placements	ENHANCE Assessment Methods	Journal, learning logs, blogs etc.
			Creativity and innovation						Portfolio
			Problem-solving		Sustainability		Practical Activities (laboratories/ field work/ site visits etc.)		Creative output: artefact, digital and broadcast media etc.
		Skills	Leadership						
			Project management and decision making		Community responsibility		Problem-based learning		Oral Presentation
		Behaviours	Professionalism	Underpinning Threads	Diversity, equality and inclusion		Project-based learning		Journal article
			Global responsibility					Underpinning Assessment Methods	Essay/Report
			Learning to learn		Social, economic and political factors		Community service		Written examination
	Underpinning Attributes	Knowledge	Theoretical knowledge				Interdisciplinary projects		Poster
			Understanding of regulations, standards and codes of practice		Human needs and human rights	Underpinning Enablers	Lectures		Online tests
		Skills	Analytical skills		International market		Seminars		Peer assessment
			Practical skills				Tutorials		
		Behaviours	Teamworking and interpersonal relationships		Culture preservation		Self-directed study		

The ENHANCE taxonomy of attributes for tackling humanitarian challenges has been developed out of the results of the survey.

This taxonomy shows the **underpinning attributes** - attributes that are already well developed in Engineering Graduates through global education systems, as well as the ENHANCE attributes - those that are proposed to be developed more strongly in education programmes.

These attributes will contribute to equipping engineering students to tackle humanitarian challenges, and to respond to community needs as well as preparing them to enter today's engineering industry.

The taxonomy is organised along three components of attributes:

(a) Knowledge: Theory, technical detail and information that is needed in order to successfully carry out a task;

(b) Skills: The practical application of knowledge needed to successfully undertake a task;

(c) Behaviours: Mindsets, attitudes or approaches needed for competence.

Whilst these can be innate or instinctive, they can also be learnt. Behaviours tend to be transferable.

ATTRIBUTES

The underpinning attributes that we have identified are:

- Theoretical knowledge,
- Understanding of regulations, standards and codes of practice,
- Analytical skills,
- Practical skills,
- Teamworking and interpersonal relationships.

We believe that graduates from most engineering programmes will receive a good grounding in these areas of knowledge, skills and behaviours. This is encouraging news because these are fundamentally important elements for a well-rounded and successful engineer. However, we have identified the following gaps which, with our innovative interventions, we shall fill:

- Realistic applications
- Creativity and innovation
- Leadership
- Problem-solving
- Professionalism
- Learning to learn
- Global responsibility
- Project management and decision making

All of these attributes are desirable within the engineering industry, and we have found that current engineering education practices leave scope for improvement in these areas.

THREADS

Certain threads have come to light that pull together the attributes that are currently strong within engineering education worldwide, and those that leave room for improvement.

By our assessment, the following threads are already addressed robustly within our education systems:

- Diversity, equality and inclusion
- Social, economic and political factors
- Human needs and human rights
- International market
- Culture preservation

But the following threads can still be improved:

- Professionalism and practice,
- Sustainability
- Community responsibility

We believe that it will be by increased focus on the Enhance threads shown in our taxonomy that engineering curricula can be enriched and strengthened, so that graduate engineers can be more effective in tackling humanitarian challenges and responding to community needs.

Having identified the Attributes and Threads that we need to build from, and those that we need to enhance, we turn to look at what teaching, learning and assessment methods we can introduce to achieve these enhancements.

ENABLERS

The Underpinning and Enhance Enablers identify teaching and learning practices that are vital to an engineering education, and those whose use in our systems must be increased.

We believe that the following methods are already well established:

- Lectures
- Seminars
- Tutorials
- Self-directed study

But the education goals that we have identified earlier can be achieved more effectively when we improve uptake of the following enhance enablers:

- Internships and industry placements
- Practical activities
- Problem-based learning
- Project-based learning
- Community service
- Interdisciplinary projects

We see these as vital to supporting our Enhance Attributes and Threads, not only because they are innovative, but because they directly support the ideas, knowledge, skills and behaviours that we are working to encourage. For example, students who take part in problem or project-based learning, particularly when they are working in teams will be developing their project management skills, problem solving, and professionalism. Through working across disciplines, they are learning to learn.

All of these activities support the professionalism and practice thread. Where projects can be integrated into community service programmes, students will be developing their awareness of community responsibility and often sustainability as well.

ASSESSMENT METHODS

As vital to an engineering programme as teaching and learning practices are the assessment methods chosen.

Our results show that engineering programmes are commonly assessed in the following ways:

- Essay/Report
- Written examination
- Poster
- Online tests
- Peer assessment

However, we have identified that there are other methods that could be introduced that would support a more active, realistic participation from students.

- Journal, learning logs, blogs etc.
- Portfolio
- Creative output: artefact, digital and broadcast media etc.
- Oral presentation
- Journal article

CONCLUSIONS

Engineers are seen as problem solvers and engineering has a pivotal role to play in addressing contemporary global challenges. Enabling attributes such as creativity, critical thinking and problem solving in engineering graduates seems to be imperative for enhancing and expanding their engagement with complex, interdisciplinary problems linked to humanitarian challenges. Tackling humanitarian challenges requires knowledgeable and erudite engineers who can handle, combine, transform and create innovative, affordable and sustainable solutions.

This view simultaneously complements and challenges current concepts of an emerging educational movement that, almost without exception, are underpinned by calls for competitive economic growth and technological development.

Within ENHANCE, we established a taxonomy of humanitarian attributes to be enabled in professional engineers, through reformed curricula and innovative learning strategies which, once implemented and integrated efficiently in higher engineering education, shall provide students and educators with opportunities to explore interdependencies and links between traditional engineering attributes with skills such as leadership and social influence, international awareness, sustainability, emotional intelligence, professionalism, cultural sensitivity and ethics, and to critically engage with implicit and explicit facets of other disciplinary identities.

Our survey demonstrated that interdisciplinary, inter-professional discussions within engineering curricula can be productive, with stakeholders expressing their willingness to support rigorous, less siloed curricula and learning strategies.

COORDINATOR

University of Warwick, UK

PROGRAMME PARTNER

University of West Attica, Greece

PARTNER

Gadjah Mada University, Indonesia
Institut Teknologi Bandung, Indonesia
Universitas Brawijaya, Indonesia
Bangladesh University of Engineering and Technology, Bangladesh
University of Dhaka, Bangladesh
Ho Chi Minh City University of Transport
Ho Chi Minh City University of Technology

enhance@warwick.ac.uk
www.warwick.ac.uk/enhance
facebook.com/EnhanceProject
@ProjectEnhance

Co-funded by the Erasmus+ Programme of the European Union

The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.