4.3

Teaching and Learning Professional Competencies through an Integrated Learning Path in the Faculty of Engineering Technology at KU Leuven

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This chapter presents the design and implementation of an integrated learning path for professional competencies within the engineering technology curriculum at KU Leuven. Responding to industry expectations and educational reforms, the Faculty of Engineering Technology introduced a holistic approach that embeds six clusters of professional competencies — team dynamics, project management, professional communication, innovation and creativity, entrepreneurship, and ethics and society — throughout the bachelor programme. Rather than treating these competencies as add-ons, they are interwoven into authentic engineering experiences that increase in complexity and openness over time, supported by just-in-time seminars, coaching, and structured feedback. Professional engineering identity development serves as the guiding principle of the learning path, fostering students' awareness of their future roles and talents while strengthening self-reflection and lifelong learning attitudes. Tools such as an e-portfolio and targeted reflection activities support this process. The chapter illustrates the approach through inspirational cases and discusses lessons learned from the multicampus implementation. Student perception data and longitudinal monitoring reveal successes, challenges, and areas for improvement. The contribution concludes with recommendations for sustaining competency development and identity formation across bachelor programmes, offering insights for engineering educators and curriculum designers aiming to integrate transferable skills into engineering curricula.

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1 Changing landscape in education and industry

The engineering profession is undergoing a profound transformation, driven by rapid technological advancements, shifting societal expectations, and evolving labour market demands. In response, engineering education institutions are shifting toward competency-based curricula that prepare graduates not only with strong technical expertise but also with the professional competencies needed to thrive in complex, interdisciplinary, and ethically charged environments. This chapter presents how such a shift has been realised at KU Leuven (Belgium) at the Faculty of Engineering Technology (FET) through the development of an integrated learning path for professional competencies.

1.1 Industry need for professional competencies

The need to foreground these competencies is echoed in both national and international labour market reports. Professional competencies are defined as the non-technical knowledge, skills, and attitudes required for effective engineering practice, including for example teamwork, communication, project management, innovation, and ethical awareness (Craps et al., 2021).

A KU Leuven study (2016) found that while employers are generally satisfied with the technical knowledge of engineering graduates, they consistently call for stronger development of professional competencies. Similarly, the World Economic Forum (2020) highlights the growing importance of competencies such as active learning, resilience, stress tolerance, and flexibility — skills that are increasingly essential in a rapidly changing world of work.

These insights underscored the need for FET to design a more structured approach to the development of professional competencies, leading to the creation of an integrated learning path — i.e., the way in which the learning is organised — (Codex Hoger Onderwijs, 2014) embedded across the bachelor curriculum.

1.2 Educational need for a coherent approach — institutional context

In Belgium, specifically in Flanders, higher-education quality assurance has evolved into a model centred on institutional responsibility. Since 2019, quality is monitored through a two-step process: internal quality assurance by the institution and institutional review by the Accreditation Organisation of the Netherlands and Flanders (NVAO). Unlike systems in countries like Ireland, Australia, or the United States, Flemish engineering programmes do not work with externally imposed discipline-specific or generic learning outcomes. Instead, institutions align with the European Qualifications Framework (EQF) (Europass, n.d.) and develop their own programme-specific learning outcomes in line with the agreements among engineering faculties in Flanders. This autonomy allows faculties to design curricula that reflect institutional vision and regional industry needs. At FET, this has led to the development of 21 programme-specific learning outcomes.

With more than 60,000 students and a strong international reputation for innovation, KU Leuven is the largest university in Flanders. It is a comprehensive, researchintensive university with programmes offered across multiple campuses. FET is one of the youngest faculties, with today over 6,000 students enrolled in engineering technology programmes across ten disciplines: agricultural and horticultural engineering, biochemical engineering, civil engineering, chemical engineering, electromechanical engineering, electronics and ICT engineering, energy engineering, food industry engineering, computer science engineering, and nuclear engineering. The faculty was established in 2013 following a merger of engineering departments from six different University Colleges of Applied Sciences. This diversity — across programmes, traditions, and regional contexts — meant that earlier implementations of professional competencies varied significantly. Some competencies were addressed implicitly or in isolated learning activities, and reflection and feedback practices differed. Students reported difficulties in linking these competencies to engineering practice or to their future engineering roles, highlighting the need for a coherent, longitudinal learning path.

This dual pressure — from industry and educational reform — created momentum for a faculty-wide curriculum redesign. In 2017, the faculty initiated the preparation of this major curriculum reform and first implementation started in 2020. One of the significant outcomes was the structural implementation of a learning path for professional competencies, ensuring that their development is intentional, progressive, and visible to students (Langie et al., 2022). Rather than treating these skills as add-ons, they are now integrated into authentic engineering tasks and assessed in ways that make their relevance tangible to students. The integrated learning path aims to support students in developing a robust professional engineering identity and a clearer understanding of their future professional roles. This approach not only aligns with the broader goals of the European Higher Education Area but also with KU Leuven's educational vision on supporting students' disciplinary future self (KU Leuven, n.d.-a).

In the following paragraphs we describe the holistic approach and the design of the learning path within the bachelor programme, concluding with critical reflections and practical recommendations.

2 Holistic approach in competency development

To ensure that students do not perceive professional competencies as add-ons but as integral to their identity as engineers, the bachelor curriculum adopts a holistic didactic approach that intentionally integrates disciplinary knowledge, practical skills, and professional attitudes. This approach positions experiential learning as a central lever for competency development and builds on well-established pedagogical frameworks on engineering education such as project-based learning and problem-based learning (Conger et al., 2010; Duderstadt, 2008; Graham, 2018; Woodcock et al., 2021).

2.1 Why experiential learning is central

Experiential learning emphasises that meaningful development occurs when students engage in authentic and complex situations (Chickering, 1976; Itin, 1999). In engineering education, such situations can include internships, multidisciplinary projects, laboratory work, community-based projects, fieldwork, and interactive simulations or games. These learning experiences differ from traditional instruction: students interact with others (peers, clients, or stakeholders) rather than in isolation, and solve concrete, real-world problems rather than engage solely with textbooks. They apply and integrate technical knowledge with professional competencies — such as communication, teamwork, or ethical reasoning — in ways that mirror real engineering practice.

These authentic contexts allow students to experience competency development as interconnected and meaningful. For example, a communication module may introduce principles of target-group communication, but it is within an Engineering Experience project that students discover their relevance when reconciling divergent team expectations (team dynamics), coordinating deadlines (project management), or debating societal implications of the proposed solution (ethics).

Experiential learning also supports students in exploring key identity-related questions: Who am I as an engineer? Which roles align with my interests and strengths? How do my competencies shape the kind of engineer I am becoming? Employers note that engineering graduates may enter the workforce with unrealistic or incomplete understanding of actual engineering roles. By engaging students' whole identity — intellectual, social, ethical, and affective — experiential learning enables them to align educational choices with their emerging professional aspirations (Craps et al., 2020).

2.2 Four pillars structuring the bachelor programme

The educational approach is reflected in the structure of the new bachelor programme. The programme is organised around four mutually reinforcing pillars (Fig. 4.3.1):

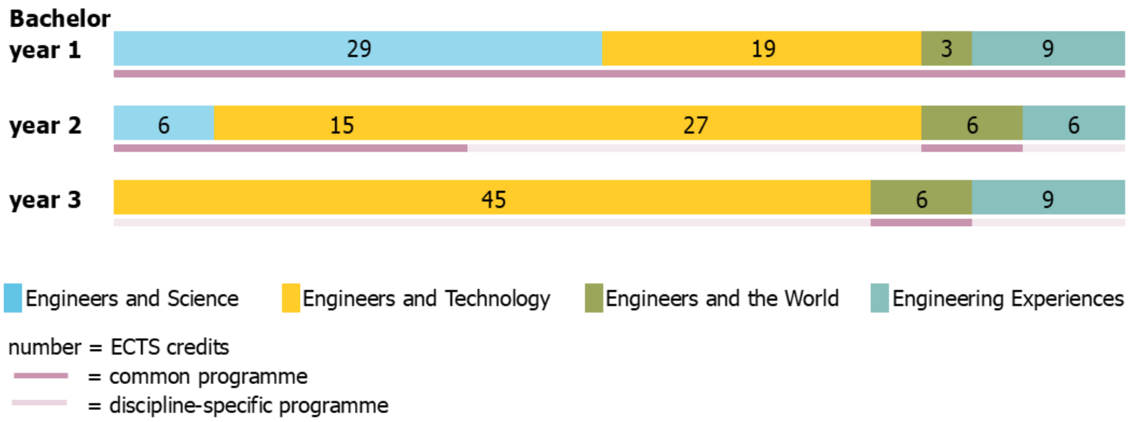

Figure 4.3.1: The four pillars of the KU Leuven bachelor programme in Engineering Technology. Own Work. Licensed under CC-BY 4.0.

1. Engineering and Science provides the multidisciplinary scientific foundations. Example modules are Fundamentals of Mathematics, Dynamics and Energy, and Computational Thinking.

2. Engineering and Technology deepens discipline-specific technological knowledge and skills. Example first-year modules are Biotechnology, Statics and Strength of Materials, and Thermal-Fluid Sciences.
3. Engineering and the World situates engineering in societal, ethical, and economic contexts, while supporting personal development and lifelong learning. Example modules are Enterprises and Ethics, Engineering and Economics, and Engineering and Sustainability.
4. Engineering Experiences offers authentic projects and challenges that allow students to integrate knowledge, skills, and attitudes, and to discover their talents as future engineers.

The learning path for professional competencies is structurally embedded across pillars 3 and 4. In the first year, students follow a common programme that lays the scientific and technological foundation. In later years, the programme gradually becomes more discipline-specific. Depending on the discipline, students can select different options or focus areas within their major. However, the learning path for professional competencies continues across all majors and specializations.

3 The learning path for professional competencies

The integrated learning path for professional competencies structures how students encounter, experience, and reflect on six competency clusters throughout the bachelor programme. This section outlines the components, identity-building elements, implementation principles, and structural embedding of the learning path across the multicampus FET.

3.1 Six competency clusters of the learning path

The learning path is structured around six competency clusters, selected based on institutional priorities, feedback from industry, and educational research (KU Leuven, n.d.-b):

- Team Dynamics refers to the dynamics within a team that support effective collaboration and the achievement of shared goals.
- Project Management focuses on planning and managing projects, including deadlines, risk analysis, adjustments, and the use of planning tools.
- Professional Communication is about communicating effectively with different target audiences, both orally and in writing, using different media and in different contexts.
- Innovation and Creativity ranges from idea generation to prototype development in assignments that evolve from relatively structured to fully open formats, often involving external stakeholders.
- Entrepreneurship covers competencies ranging from understanding business fundamentals (e.g., annual accounts or investment proposals) to identifying opportunities and developing ventures.
- Ethics and Society addresses responsible and ethical behaviour as an engineer, including sustainable design and development.

These clusters develop iteratively throughout the bachelor programme and are reinforced through both dedicated modules and pillar 4, Engineering Experiences (see Section 2.2). Students encounter them in seminars, apply them in authentic tasks, and reflect on their development over time.

3.2 Engineering identity as guiding thread

A key aim of the learning path is to support students in developing a clearer sense of their emerging engineering identity. Through authentic engineering experiences that increase in openness and complexity, students explore their talents, preferences, and potential future roles.

Professional competencies are therefore not presented as abstract expectations but as integral elements of professional engineering practice. This explicit connection between action and reflection helps students understand why these competencies matter and how they shape the kind of engineer they are becoming.

To facilitate this process, we embedded several instruments that support identity development and competency growth. For example, the e-portfolio allows students to document their learning, set goals, track progress, and reflect on their development across the programme (Dujardin et al., 2024). Example 1 illustrates this process in more detail.

In addition, the PREFER tools (Professional Roles and Employability for Future EngineeRs) provide students with validated insights into early-career engineering roles, the competencies associated with these roles, and their own preferences and talents (Craps et al., 2021; Langie & Craps, 2020). The tools include (1) a competency-based framework describing three typical engineering roles for early career engineers; (2) a personal preference test that helps students explore which roles align with their motivations; and (3) a situational judgement test that offers feedback on role alignment and competency strengths. By linking these insights to engineering experiences, students can better recognise which competencies are important for the roles they aspire to and identify areas for further development.

Although this chapter focuses on the bachelor programme, this trajectory continues in the master programme through elective modules, internships, and advanced projects. Identity development and competency growth thus form a coherent learning path from the first year to graduation.

Example 1. Integrating projects, competencies and identity development through the e-portfolio

The e-portfolio is structured around a Personal Development Process (PDP), with five iterative steps: identifying competency gaps, setting goals, acting on a learning plan, monitoring progress, and reflecting on future needs (Dujardin et al., 2024). This process is embedded in pillar 4, Engineering Experiences, where students receive seminars on professional competencies and apply these directly in the project work.

Each semester, students individually engage in reflection activities such as:

- *Self-assessment on a series of professional competencies (e.g., teamwork, communication, ethical thinking, perseverance);*
- *Setting and planning concrete actions for improvement of a self-selected competency;*
- *Monitoring actions and documenting progress;*
- *Reflecting on feedback from coaches (three times per semester);*
- *Linking competencies to engineering practice and personal aspirations, strengthening the connection between academic work and future professional roles.*

The PREFER tools (PREFER, n.d.) are integrated into the portfolio to connect competency development to professional roles, reinforcing the link between professional engineering identity and practice. Each semester, students receive feedback on their reflection on self-assessment and action plan, monitoring, and takeaways.

The e-portfolio is embedded in Blackboard Ultra, KU Leuven's digital learning environment. Students can actively steer and monitor their learning process and that of their peers through online tests, discussion forums, e-portfolios, etc. Participation in the e-portfolio is part of the final evaluation of the Engineering Experiences modules.

3.3 Structured growth through the sub-learning paths

The curriculum reform was a collaborative effort involving multiple expert teams. Each team was tasked with designing a learning path for a specific knowledge domain or competency cluster, ensuring a coherent trajectory from the start to the end of the bachelor programme. Hence, each competency cluster was translated into a sub-learning path outlining how students encounter, practise, and deepen the competency across the curriculum. These sub-learning paths are:

- clarify expected progression across years;
- support alignment between campuses;
- guide educators in planning and coaching;
- help students understand how competencies evolve over time.

A sub-learning path includes seminars, authentic tasks, feedback loops, and reflection activities. Example 2 illustrates how this works for the competency professional communication.

Example 2. Building a sub-learning path Professional Communication that goes beyond writing and presentation skills

The sub-learning path Professional Communication creates the opportunity to practice the classical skills such as writing and presentation skills, but also other essential competencies. Every year, it offers students strategic communication skills and feedback literacy skills. In the first bachelor year, students learn the foundations *of effective communication tailored to target audiences. In Year 2, the focus shifts to connective communication within teams and with external stakeholders, such as clients. In the third year, students develop persuasive communication skills.*

Students are introduced to core communication principles and tools, supported by a guidebook summarizing the theory, principles, and faculty agreements (use of British English spelling, IEEE or APA reference style, report templates, etc.) which they use throughout the programme. Students progressively develop genre-specific skills, such as presentation skills (Year 1), visualisation skills (Year 2) and scientific reasoning skills (Year 3).

In the master programme, the learning path of the bachelor programme continues with a series of elective modules, such as sales techniques, intercultural communication, principled negotiation, and interpersonal coaching, allowing for further specialisation.

3.4 Principles guiding implementation in practice

The implementation of the learning path follows a modular structure grounded in three key pedagogical principles. These principles ensure that the competency clusters and sub-learning paths are enacted meaningfully and consistently across modules and projects.

1. *Just-in-time seminars* introduce relevant competencies when students need them for specific tasks or projects. This ensures that theoretical input is applied immediately, which increases its perceived relevance.
2. *Training moments in authentic tasks* allow students to apply competencies within discipline-specific and interdisciplinary engineering contexts. These experiences help students to perceive competencies as interconnected and essential for engineering work.
3. *Assessment and feedback through coaching* provide iterative formative feedback rather than one-off evaluation. Students receive guidance on their progress, strengths, and development needs, supporting reflective practice and sustained growth.

Ongoing monitoring shows that coaching, interdisciplinary collaboration, and just-in-time instruction have proven essential for successful implementation (see Section 5).

3.5 Realising coherence across a multicampus faculty

FET is spread across several campuses, each with its own traditions, research expertise, and regional industry connections. The learning path ensures that:

- Intended learning outcomes remain aligned across campuses;
- Competency expectations are consistent;
- Students follow parallel developmental trajectories;
- Campuses can contextualise learning using local expertise and partnerships.

Given the different traditions regarding professional competencies across campuses and disciplines, the structured learning path provided essential guidance for campuses with fewer established practices in this domain. The implementation required more effort for some campuses than for others. We therefore adopted an iterative implementation process, allowing campuses to progressively integrate the learning path while building capacity and experience. This process is still ongoing.

This balance between alignment and contextualisation has been essential for implementation. It allows campuses to design innovative project themes while maintaining a shared competency framework across the faculty.

4 Inspirational cases

The following cases (Examples 3-5) illustrate how the learning path for professional competencies is implemented across our multicampus faculty. They show how shared principles are enacted in diverse contexts while maintaining alignment in intended learning outcomes.

Example 3. Variation in topics and challenges — from building glass houses to Rube Goldberg machines

In the first-year module Engineering Experience 1, students engage in open-ended projects that integrate technical and professional competencies. Although campuses use different project themes, all aim to achieve the same learning outcomes.

Project structure:

- *Duration: 12 weeks in the second semester of the first year.*
- *Students work in interdisciplinary teams (3-10 students depending on campus).*
- *Projects integrate the four main engineering disciplines (Electromechanics, (Bio)Chemical, Electronics-ICT, and Construction Engineering).*

Example themes:

- *Rube Goldberg Machine: students design a complex machine to move a golf ball that integrates mechanisms from mechanical, chemical, electronic, and civil engineering into a unified system.*
- *Greenhouse of the Future: students design a sustainable greenhouse prototype. Sub-teams focus on structural design, bioreactor systems, automation, and environmental sensing, requiring cross-team collaboration to integrate solutions.*

Professional competency integration:

- *Just-in-time seminars introduce teamwork, project management, and presentation skills.*
- *Coaching is provided by technical coaches for discipline-specific support, and by professional competency coaches for team dynamics, planning, and communication.*
- *Assessment includes progress presentations and peer feedback, with increasing autonomy across the semester.*

Key takeaway:

Variation in themes stimulates creativity and local ownership, while shared learning outcomes ensure coherence in competency development across campuses.

Example 4. Creative Makers — an interdisciplinary experience that blends technology, design, and societal inquiry

This third-year project challenges students to design and build an indoor vertical farming setup, inspired by Dickson Despommier's concept (Platt, 2007), in collaboration with students from the faculty of Architecture and Visual Arts. The project highlights interdisciplinary collaboration and intertwined professional competencies.

Project structure:

- *Students work in specialized sub-teams (e.g., lighting, water systems, plant beds).*
- *The project spans two academic years, with iterative development across cohorts. Documentation is passed on to the next group.*
- *Rapid prototyping workshops initiate the project to stimulate creativity and experimentation.*

Professional competency integration:

- *Innovation and creativity are fostered through design constraints and time pressure.*
- *Project management is practiced through planning, coordination across sub-teams, and iterative development.*
- *Communication is critical in interdisciplinary settings. Students learn to adapt technical language for non-engineering peers.*
- *Visual communication is emphasized through sketches, photos, and concise documentation.*

Coaching format:

- *Two supervisors per team: one with technical expertise, and one with limited technical background, encouraging clear explanation.*

Teams use Discord for team coordination, revealing challenges in responsibility and internal communication. When such challenges arise, supervisors help students understand the potential consequences of their communication style in a professional setting and identify appropriate ways to address them. Key takeaway:

Interdisciplinary collaboration strengthens students' ability to articulate ideas, negotiate perspectives, and apply competencies in diverse professional contexts.

Example 5. Internal and external collaboration — partners in crime

This case illustrates collaboration with KU Leuven Libraries to integrate information literacy and AI literacy into the curriculum.

Project structure:

- *Information literacy is embedded in professional competency modules across the bachelor programmes.*
- *First-year students complete an online module followed by hands-on sessions in Engineering Experiences 1.*
- *Advanced sessions are tailored to discipline-specific needs.*

Professional competency integration:

- *Information literacy includes source evaluation, referencing, and ethical use of information.*
- *AI literacy supports students in critically assessing AI-generated content and in navigating digital ecosystems.*
- *Sessions are timed to align with academic writing sessions to enable direct application (e.g., research papers, technical reports).*

Collaboration format:

- *Library staff co-develop teaching materials and provide student sessions or online support.*
- *Coaching is provided by technical coaches for discipline-specific support and by professional competency coaches for writing skills and information literacy.*
- *External partners (e.g., industry professionals) may contribute real-world perspectives as a starting point for projects and information searches.*

Key takeaway:

These type of strategic partnerships by engaging relevant internal and external partners expand the learning path and ensure timely integration of emerging competencies.

5 Monitoring and evaluation

From the outset of the curriculum reform, systematic monitoring evaluated whether intended goals were achieved and identified areas for improvement. The monitoring strategy combined longitudinal student perception measurements with qualitative feedback from teaching staff and policy teams. This mixed-methods approach enabled the faculty to track changes over time and better understand how programme elements were experienced across campuses.

5.1 Monitoring approach

A longitudinal perception study, based on a questionnaire, was conducted among students in both the old and the new curriculum (KU Leuven Faculty of Engineering Technology, 2025). The study covered 16 themes — including professional competencies, interaction with the labour market, practical experiences, societal relevance, interdisciplinarity, and lifelong learning — and used a six-point Likert scale. Data were gathered at multiple moments across the bachelor and master programmes (Fig. 4.3.2).

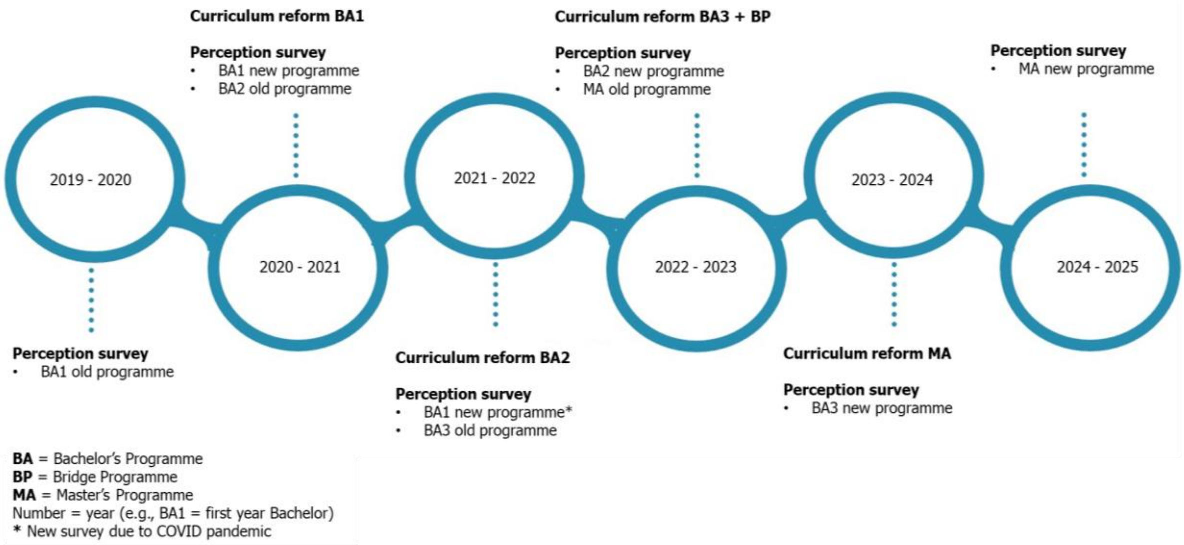

Figure 4.3.2: Timing of curriculum implementation and perception surveys. From Perceptiemeting Rapport by KU Leuven Faculty of Engineering Technology (2025). No further use allowed.

In 2019-2020, a baseline measurement was conducted in the old programme (first-year bachelor, BA1), followed by the first cohort in the new programme in 2020-2021 (Langie et al., 2022). Between 2022 and 2024, follow-up measurements tracked the developmental trajectory of subsequent cohorts. In total, 720 bachelor students participated in the old-programme survey (response rate 30%), while 516 students participated in the new-programme survey (response rate 28%) (KU Leuven Faculty of Engineering Technology, 2025).

This monitoring approach enabled the faculty to identify trends over time, compare cohorts, and inform programme adjustments at both faculty and campus level.

5.2 Student perceptions: what improved, what needs attention

The perception measurement for the theme professional competencies included four statements capturing students' experiences with communication, project management, business awareness, and the perceived relevance of professional competencies in engineering practice.

Table 4.3.1 presents the percentage of students that agree with the statement (score 4 or above) and the mean score. The results indicate that students in the new curriculum experienced stronger development of professional competencies. Two statements showed statistically significant improvement:

- Students more often indicated that they have trained specific communication skills (M = 4.08 vs. 4.27, $p<0.05$; 70% vs. 77%);
- Students felt more encouraged to make progress in the field of project management (M = 3.98 vs. 4.16, $p<0.05$; 66% vs. 76%).

Students in both programmes acknowledged the general importance of business knowledge and the usefulness of professional competencies for engineering practice.

Table 4.3.1: Students' perception of professional competencies in old and new bachelor programme (percentage agree and mean score with agree = Likert scale 4 (somewhat agree), 5 (agree) or 6 (strongly agree).

	BA old	*BA new*	*p-value*
This year, I have trained certain communication skills.	70% (4.08)	77% (4.27)	<0.05
This year, I have learned that it is important for engineers to have knowledge of business (e.g. business models, financial aspects, etc.) in addition to technical expertise.	78% (4.35)	82% (4.41)	n.s.
This year, I was encouraged to make progress in the field of project management.	66% (3.98)	76% (4.16)	<0.05
This year has made me aware of the usefulness of professional competencies (e.g. communication, planning, meeting, leadership, etc.).	85% (4.58)	83% (4.50)	n.s.

A deeper analysis showed that Year 1 students in the new programme scored highest on awareness of the usefulness of professional competencies (M = 4.68, SD = 0.96), although scores declined slightly in later years (Year 2: M = 4.26; Year 3: M = 4.43). This pattern highlights the need for sustained visibility and reinforcement of competencies as students' progress into more discipline-specific phases.

Differences between campuses also emerged, which was expected given diverse traditions in professional competency development. Combining perception data with other themes (e.g., industry interaction, interdisciplinarity, societal relevance, and feedback) enabled more targeted programme optimisation across campuses.

5.3 Experiences and challenges in implementation

The implementation of the learning path has led to several successes but also revealed challenges that require continued attention. The following insights highlight what worked in practice and which issues required targeted interventions, offering you concrete takeaways.

Successes

One of the successes is that students, in particular in the first year, recognise the integration of professional competencies in authentic projects as relevant and valuable. In conversations, students report that professional competencies feel more meaningful when they are applied in engineering experiences rather than taught as isolated elements.

Second, professional engineering identity development is strengthened. Reflection tools and coaching support students in making sense of their developing competencies and future professional roles, especially in the early years when foundational modules may feel distant from engineering practice. Research showed that students' future-oriented perspectives influence how relevant and motivating they perceive their studies to be (Schepers et al., 2026). However, continued support is needed after the common first year, when students transition into discipline-specific majors.

Third, the curriculum reform fostered faculty-wide engagement and educational innovation through co-creation. The reform process was collaborative, involving teaching staff and experts across campuses and disciplines. This collaboration extended beyond formal meetings: educator teams jointly redesigned modules, shared teaching materials and practices, and experimented with on-campus and hybrid formats. Educator teams can apply for small-scale funding, e.g., student assistants to support module development in the digital learning environment. Regular newsletters and faculty stories increased visibility of good practices and recognised the work of dedicated colleagues.

Challenges

It is evident that the new programme also has some challenges. A first challenge we face is sustaining student engagement. This depends on how well the projects are organised and to what extent the professional competencies are truly integrated. Some competencies become less visible in later years. To address this, the e-portfolio was introduced to support continuity across years, complemented by short in-class reflection prompts that help educators reconnect to competencies addressed in earlier modules. Example 6 illustrates guiding questions to strengthen project management skills. Educators can use these to reinforce what was learned in earlier modules.

Example 6. Do students in your module work on a project?

To help students practise project management in a low-stakes manner, you can use short guiding questions during regular project meetings or reflection moments. These prompts make competencies visible and encourage students to articulate their planning and decision-making processes.

Guiding questions for students:

- *Can each team member describe in their own words what needs to be produced? What conditions must this output meet? (acceptance criteria for output)*
- *Has the team developed a milestone schedule for completing this project? Which tasks need to be completed first? Which are the dependencies between tasks?*

- *What risks do you foresee in the implementation of this project? How has the team planned to address or mitigate these risks?*

Educators can contact the project management expert on their campus for additional support, feedback or further examples.

A second challenge concerns the consistency of feedback and assessment quality. While students value feedback opportunities, they report variability in timing and usefulness. Educators, in turn, indicate a need for more support and tools to provide competency-based feedback. To address this, we have been working on feedback prompts and evaluation criteria in ready-made rubrics. However, while some competencies lend themselves to rubrics (e.g., writing skills), others (e.g., team dynamics) are harder to assess in a standardised way (if any assessment is desirable). Tools, such as FeedbackFruits, support structured (peer) feedback. This digital tool includes educator feedback (skills review and assignment review), student feedback (group member evaluation and peer assessment), and personal feedback (self-assessment of skills and self-assessment of work).

A third challenge relates to the complexity of large and open-ended projects. Engineering experiences integrate multiple learning goals and involve diverse stakeholders, which can lead to cognitive overload. Students may become overwhelmed, prioritise task completion over learning, or spend excessive time on projects. Variation in project design and coaching expertise can further affect whether intended learning outcomes are achieved consistently across teams.

A fourth challenge is sustaining faculty engagement within existing workload constraints. The success of the learning path depends on broad involvement and continuous professionalisation of teaching staff, which is not always self-evident. In addition, temporary contracts in academia require continuous investment in staff development and alignment.

Our experience shows that appointing teaching staff with an explicit focus on professional competencies — who coordinate across programmes, develop materials, and organise training — is crucial for successful implementation. However, these roles were not always formally recognised during the initial curriculum reform, which sometimes led to work overload and disengagement, in particular when some (technical) teaching staff were not yet convinced of the integrated approach, were reluctant to change, or were afraid to lose teaching hours. Although this is currently more widely acknowledged, in a context of budget constraints, this remains fragile: much of the workload associated with coordination, coaching, and iterative project design is less visible in formal teaching hours compared to other modules.

5.4 Lessons learned

The evaluation results show that integrating professional competencies into authentic engineering tasks enhances students' sense of relevance and supports the development of their emerging engineering identity. At the same time, variation in campus traditions, feedback practices, and project formats demonstrates that implementing an integrated learning path requires continuous coordination, support, and reflection. Ensuring sustained visibility of competencies and maintaining a consistent coaching approach remain key points of attention as the programme evolves. In the next and final section, we translate these observations into concrete actions for you, educators and curriculum designers.

6 Recommendations and next steps

Based on the lessons learned, we offer seven recommendations that can support you in strengthening the development of professional competencies in engineering education. These recommendations are intentionally practical: they draw directly from approaches that proved valuable in our multicampus implementation and can be adapted to your specific setting.

6.1 Strengthen continuity and visibility across the curriculum

Professional competencies must remain visible beyond first-year projects. Extend opportunities for practice and reflection across modules throughout the programme. You can use clear signposting within modules — such as explicitly stating which competencies are addressed, using icons in weekly overviews, or making links in assignment briefs — to help students recognise that these competencies are integral to engineering practice, not just a module requirement. Advanced projects, electives, and internships offer opportunities for students to deepen and refine these competencies. Ensure that resources such as communication guidelines, presentation criteria, knowledge clips, or project management tools remain accessible throughout the entire bachelor programme, rather than being confined to individual modules.

6.2 Invest in professional development for teaching staff

Not all colleagues feel equally confident in coaching professional competencies. Targeted, low-threshold professional development initiatives — such as short workshops, lunch talks, or peer exchange sessions — can help educators become more comfortable with providing competency-based feedback and supporting students' development. In our faculty, the teaching team provide regular training sessions and talks, ranging from workshops at the faculty's educator day (e.g., 'Explore and experience: Toolbox Creativity and Innovation') to lunch talks (e.g., 'Peer feedback and writing skills: online and/or on campus?') to low-stakes guidelines for transfer of knowledge and skills to other modules. Making core materials easily accessible (e.g., templates, slides, feedback forms, examples of student work) helps educators integrate competencies without increasing workload.

6.3 Involve professional competency experts early in module design

Professional competency educators can make the greatest impact when they are involved from the start of module design or redesign. Early collaboration enables shared learning goals, coherent assessment expectations, and better alignment with the sub-learning paths. This prevents competencies from becoming late additions and fosters stronger integration with technical content. In practice, we observed that modules redesigned in close collaboration with professional competency experts required fewer adjustments during implementation.

6.4 Enhance feedback culture with aligned tools and guidelines

High-quality feedback is essential for competency development yet challenging for educators and students alike. Faculty-wide rubrics, feedback prompts, and digital tools help create consistency. Tools such as FeedbackFruits have been particularly valuable for structuring educator, peer, and self-feedback. You can check with educators and students what works best in their context. For example, the educators preferred paper feedback forms for presentations (covering content, structure, storytelling, delivery, layout, and visuals). The forms are used across disciplines and academic years, improving clarity for both students and assessors. Encouraging students to provide peer feedback and to reflect on feedback received also strengthens their metacognitive skills and sense of ownership.

6.5 Support educators with concrete and transferable tools

Educators benefit from concrete instruments that help them integrate professional competencies into existing modules. Example 6 demonstrated how guiding questions about acceptance criteria, milestone planning, and risk identification can be used in any module involving project work. Similar checklists exist for teamwork, communication, or ethical reasoning. These small, practical instruments lower the threshold for integration and support colleagues who are less familiar with coaching in professional competencies.

6.6 Share success stories and strengthen peer learning

Colleagues are more likely to adopt new approaches when they see how others in their context have made them work. Sharing success stories — through newsletters, faculty events, or informal discussions — helps build a shared culture and encourages experimentation. Educators who personally experience the benefits of well-developed professional competencies in their modules become the best ambassadors. They can tell from experience that it is much more rewarding to evaluate a well-written lab report, observe a team that planned effectively, or see students adapt constructively to unforeseen challenges because they communicated well and organised their work thoughtfully. Also, stories from students describing how professional competencies supported their project work or internship experiences have shown to be highly motivating. These narratives highlight what works and what does not and help refine the learning path.

6.7 Monitor impact through a mixed methods approach

You can gain a more complete understanding of how students and staff experience competency development by combining quantitative and qualitative data. While longitudinal surveys track perceptions over time, interviews, focus groups, or informal reflection activities help uncover underlying reasons and nuanced experiences. Patience is important: implementing a coherent learning path is a long-term process and evaluating it requires time to allow practices to take shape and mature.

7 Conclusion

The iterative development and implementation of the learning path have shown that integrating professional competencies into engineering education is both feasible and impactful. At the same time, it requires ongoing collaboration, visibility, feedback, and evaluation. By strengthening continuity, supporting teaching staff, embedding consistent feedback practices, and monitoring outcomes, you can help students build a strong professional engineering identity and be better prepared for professional practice.

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AI statement

During the preparation of this work, the authors used Microsoft Copilot in order to improve the storyline and to check for grammar and spelling. After using this tool, the authors reviewed, edited, and made the content their own as needed. They take full responsibility for the content of the publication.

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