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Integrating Self-Directed Learning: Professional and Personal Development in the Industrial Design Bachelor Programme at Eindhoven University of Technology

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This chapter presents the curriculum redesign of the bachelor programme in Industrial Design at Eindhoven University of Technology (TU/e), with a focus on designing a Professional and Personal Development (P&PD) learning trajectory within a competence-centred learning framework. Aligned with the TU/e Bachelor College redesign, the initiative aims to enhance employability by strengthening competencies acquired both inside and outside formal coursework. Central to this approach is self-directed learning (SDL), which fosters autonomy, adaptability, goal setting, and lifelong learning, skills vital for addressing complex design challenges in rapidly evolving technological contexts. The P&PD learning trajectory, integrated throughout the programme, guides students in shaping a professional identity while applying competencies in authentic contexts through a complementary challenge-based learning (CBL) programme. Supported by coaches on project contents and professional development, students connect personal growth with professional practice in a collaborative and student-centred environment. The redesign process drew on van den Akker's curriculum principles systems and design thinking, and on Biggs' constructive alignment to ensure coherence among outcomes, activities, and assessment. Bloom's taxonomy was used to align learning outcomes across academic years. A participatory approach involving faculty, staff, and stakeholders helped foster a sustainable culture of educational innovation. Insights from students, coaches, and programme management indicate that the renewed SDL framework effectively supports the development of five interconnected competencies and skills essential for industry-ready designers. The P&PD learning trajectory, and particularly its SDL component, demonstrates positive effects on student learning and offers transferable lessons for institutions seeking to embed SDL and CBL into their curricula.

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1 Introduction

The Department of Industrial Design (ID) at Eindhoven University of Technology (TU/e) has developed an educational model that is both innovative and responsive to the rapidly changing demands of society, industry, and technology. Grounded in a competency-based educational philosophy, the curriculum emphasises not only the acquisition of knowledge, competencies, and skills, but also the development of professional attitudes and behaviours that enable students to act as reflective, responsible, and adaptive design professionals. Central to this model is student-driven learning, in which learners actively shape their development pathways through authentic design projects, interdisciplinary collaboration, and engagement with real world challenges. To further support this, a Professional and Personal Development (P&PD) learning trajectory, evolving from the earlier Professional Vision and Identity (PV&I), was integrated to strengthen competence development and professional growth.

Established in 2001, the ID department was founded to educate a new generation of design engineers capable of bridging technology, human needs, and societal challenges. From its inception, the programme aimed to prepare graduates to conceive and develop intelligent systems, products, and services within complex societal contexts. This vision is reflected in the integration of design practice, scientific inquiry, theory, and reflection, fostering a continuous interplay between doing, thinking, and learning. Students work on real world challenges through challenge-based learning (CBL) projects, often in collaboration with research staff and a broad ecosystem of external societal and industrial partners (Doulougeri et al., 2024).

Within this flexible curriculum, self-directed learning (SDL) enables students to make informed choices regarding projects and modules, effectively designing their own learning paths. Students are supported in this process through mechanisms such as project markets, where they the explore content and learning requirements of available projects before making deliberate selections. This approach empowers students to take ownership of their learning, to experiment and iterate, and to construct a professional identity aligned with both personal aspirations and societal needs. As a result, the ID educational model has gained recognition as a distinctive and influential example within Dutch higher education (Gómez Puente & Doulougeri, 2022; Hummels et al., 2011; Van Diggelen, 2020).

In the context of rapid technological advancement, global challenges, and evolving labour markets, SDL has emerged as a vital competence for 21st century professionals. Within engineering education, SDL supports learners in developing the cognitive, emotional, and metacognitive capacities necessary to navigate uncertainty and interdisciplinary innovation (Candy, 2004). The emphasis on ownership, reflection, collaboration, and community learning within the TU/e ID curriculum therefore aligns strongly with contemporary understandings of SDL as an essential competency in higher education.

This chapter presents an empirically grounded case study on how self-directed learning can be embedded at curriculum level within engineering and design education. By linking educational theory to concrete practices in the TU/e ID programme, the chapter supports the handbook's aim of connecting conceptual frameworks with practical examples that inform educational innovation across contexts.

1.1 Theoretical framework: exploring the concept of self-directed learning empirically

Self-directed learning is commonly understood as the ability to intentionally plan, monitor, and reflect on one's learning journey in pursuit of personal, academic, or professional goals (Ahiskali, 2024; Beagon et al., 2025). It encompasses identifying learning needs, setting goals, selecting and applying strategies, and evaluating outcomes (Beagon et al., 2025). Rather than a natural ability, SDL is a learnable and teachable set of skills that underpin lifelong learning, and is an essential attribute for engineers, whose professional growth extends beyond formal education (English & Kitsantas, 2013).

Contemporary perspectives on SDL provide a lens for understanding the curriculum of the ID department at TU/e. In this context, student autonomy is framed as integrated competencies, such as metacognition, motivation, and professional identity development, underpinning the department's student-driven, project-based approach (Kanar & Bouckenooghe, 2021). Within the TU/e ID curriculum, students take ownership of their learning by engaging in authentic design challenges, iterating on solutions, and reflecting critically on process and outcomes. This aligns with the 21st-century skills framework (Binkley et al., 2011), where SDL intersects with critical thinking, creativity, and initiative, explicitly nurtured in design projects and collaborative learning communities.

Zimmerman's (2002) cyclical model of self-regulated learning — forethought, performance, and self-reflection — provides a theoretical underpinning for the TU/e ID approach, highlighting how students plan, execute, and evaluate design activities in iterative cycles. Garrison's (1997) conceptualisation of SDL as the interplay of self-management, self-monitoring, and motivation aligns with the curriculum's emphasis on autonomy, collaborative responsibility, and goal-directed learning. Knowles' (1975) work on adult learning reinforces intrinsic motivation and learner autonomy, embedded in the curriculum through self-directed projects, cross-disciplinary collaboration, and reflective practices. Together, these perspectives illustrate how the TU/e ID model operationalises autonomy, translating principles into learning experiences that prepare students for complex, real-world design challenges.

Building on these perspectives, the following section (1.2) explains how SDL constructs are implemented in the TU/e ID curriculum. This shift from theory to practice shows how these frameworks inform design decisions, scaffolding strategies, and educational interventions. Sections 2 and 3 therefore illustrate how SDL principles

are enacted through the P&PD learning trajectory and embedded in everyday learning activities.

1.2 SDL in the context of the TU/e ID programme

At TU/e, we operationalised SDL through:

- *Autonomous motivation.* Encouraging students to set personal learning goals, fostering intrinsic motivation.
- *Learning beliefs and strategies*. Developing metacognitive awareness and effective learning strategies by supporting students in iteratively shaping their professional identity, design vision, and personal development plans in relation to societal, environmental, and technological contexts.
- *Initiative and perseverance*. Fostering a proactive and resilient mindset through iterative personal development planning and reflection on challenges and achievements.

These elements align with professional commitment and lifelong learning competencies and support autonomous motivation, learning beliefs, and perseverance. The TU/e ID curriculum fosters these competencies through challenge-based projects, interdisciplinary collaboration, and reflective practices that promote self-assessment and continuous improvement.

1.3 SDL in the context of the TU/e Bachelor College

In the pursuit of educating engineers for the future, the TU/e Bachelor College (BC) led the redesign of its bachelor programmes in 2022-23. The TU/e BC is the umbrella structure for all TU/e bachelor's programmes. It was designed to educate 'future-proof engineers' who can address societal and technological challenges while having flexibility in their academic development and give students a solid engineering foundation while allowing them to tailor part of their curriculum to their own interests and career goals. The design principles were guided by the college and institutional directives, which placed an emphasis on the development of a Professional and Personal Development (P&PD) learning trajectory to deliver responsible and 'future-proof' engineers. All TU/e bachelor programmes have been redesigned to integrate the BC core elements as set out in the directives. However, the inclusion of P&PD in each programme followed a 'diversity-by-design' approach to encourage contextual and programme-specific embedding in the curriculum.

SDL was approached at TU/e and is recommended as being embedded within the broader educational ecosystems and lifelong learning environments at TU/e and therefore should not be viewed in isolation. At TU/e this meant:

- Just-in-time learning that supports immediate application of knowledge.
- Collaborative learning, where individuals self-direct within teams and communities of practice.
- Critical thinking that enables learners to evaluate strategies, sources, and outcomes.

- Communication skills that facilitate articulation of learning goals and reflective dialogue with peers and mentors.

Together, these elements reflected a paradigm shift from static knowledge acquisition to learning agility, which at TU/e means instilling the capacity to learn, unlearn, and relearn throughout one's career and aptly through a student's learning trajectory.

1.4 Development of SDL in engineering education

The relevance of SDL for future engineers stems from its support for the development of lifelong learning capabilities. Frameworks such as CDIO (Crawley et al., 2014) and the T-shaped engineer model, which combines disciplinary expertise with broad professional and interdisciplinary competencies, emphasize autonomous learning, open-ended problem solving, and collaboration across disciplines and cultures.
In engineering education, student autonomy is systematically embedded in the curriculum and operationalised through five interrelated sub-skills:

1. Goal setting involves defining clear and attainable goals that sustain motivation and align personal interests with professional competencies, ranging from acquiring technical skills to contributing to multidisciplinary design challenges (Christopher et al., 2023).
2. Planning entails identifying learning needs and structuring timelines and activities to achieve learning outcomes. In engineering education, it supports project-based and agile workflows that enable iterative progress and innovation (Li et al., 2023).
3. Self-regulation refers to monitoring and managing learning processes, including time management, strategic adaptation, and emotional resilience. Self-efficacy strongly influences persistence and adaptability in uncertain and failure-prone design contexts (Stofiana et al., 2025).
4. Reflection promotes learning through critical evaluation of experiences and decisions, supporting conceptual understanding and ethical awareness, particularly in design and sustainability contexts (Christopher et al., 2023; Jackson, 2025).
5. Professional identity and vision enable learners to connect current learning to long-term professional aspirations by developing a sense of direction, values, and self-concept as engineers, fostering lifelong learning and adaptability (Dehing et al., 2013; Trevelyan, 2014).

2 The significance of SDL in the ID bachelor programme: redesigning SDL into the professional and personal development (P&PD) learning trajectory

In response to these challenges and following the Bachelor College curriculum redesign initiative in 2022 (Gómez-Puente et al., 2020), the ID programme integrated a mandatory, longitudinal Professional and Personal Development (P&PD) learning trajectory. This redesign reflects a university-wide shift toward competence-based, student-centred education, with a strong emphasis on SDL, reflective practice, and

professional identity development. SDL activities complement the P&PD learning line by supporting students in goal setting, continuous feedback, and coaching, and the development of adaptive expertise needed in interdisciplinary engineering contexts.

The redesign of the ID bachelor curriculum at TU/e took place in 2023 and was guided by van den Akker's curriculum spider web model, which shows that educational elements such as objectives, assessment, teachers' role and alike are interconnected with each other in a curriculum (van den Akker, 2003), Bloom's taxonomy, and constructive alignment principles (Biggs et al., 2022). The aim was to scaffold students' metacognitive growth from basic reflection toward independent goal setting and professional identity formation. SDL was embedded in the P&PD learning trajectory to support the development of transferable competencies and skills that are not tied to a specific discipline or role but are essential in dynamic professional environments. These include goal setting, personal development planning, self-regulation, collaboration, reflection, and the development of Professional Identity and Vision (PI&V). Learning objectives and assessment rubrics for P&PD were aligned primarily with the first three levels of Bloom's taxonomy (Remember, Understand, Apply).

Across the three programme years, the P&PD learning trajectory supports a progressive development of PI&V:

- In Year 1, students articulate their emerging PI&V based on learning activities and outcomes.
- In Year 2, students explain relationships between competencies while further developing their PI&V.
- In Year 3, students use their PI&V to guide competence development plans for their final bachelor projects and beyond.

The P&PD learning trajectory was co-designed through department-wide education days involving students, staff, educational developers, and the Education Management Team. The learning trajectory includes lectures on competence-centred learning and SDL, peer mentoring, skills-focused training sessions (e.g., planning, teamwork, information literacy, and project pitching), and coaching sessions for reflection and feedback. In addition, students complete assignments related to SDL sub-skills. Educators, student mentors, and coaches (academic staff that coach project teams) fulfil complementary roles, together providing structured P&PD learning experiences alongside the disciplinary curriculum of the ID bachelor programme.

3 Curriculum innovation and change management for self-directed learning at TU/e ID

The integration of SDL within the TU/e ID curriculum has been realised through a long-term process of curriculum innovation and change management. Rather than introducing SDL at the level of individual modules, the department deliberately embedded it as a guiding principle across the curriculum, requiring alignment between institutional vision, educational strategy, and everyday teaching practices.

This process can be understood through Kotter's (2012) change management framework. A shared sense of urgency was created by articulating a clear vision of the designer as a reflective and autonomous professional. A guiding coalition of educational leaders and faculty members translated this vision into curriculum reforms, supported by iterative pilots that served as short term wins and built momentum for broader implementation.

Over time, SDL became structurally embedded through curriculum reviews, coaching practices, and the P&PD learning trajectory. These mechanisms ensured that student autonomy was sustained beyond individual initiatives. At the same time, embedding SDL remains an ongoing process that requires continuous attention to evolving educational and societal contexts.

3.1 Alignment with university vision on education

TU/e has articulated a university vision of educating 'engineers of the future', i.e., graduates who are self-directed learners capable of making informed choices and taking responsibility for their development (Eindhoven University of Technology, 2023). In the ID department, this vision is operationalised through the integration of SDL into the curriculum, positioning students as active agents in shaping their own learning journeys. SDL is not treated as an isolated skill but as a competence that permeates all aspects of the programme, connecting design practice, reflection, and personal growth (Knowles, 1975; Zimmerman, 2002).

The P&PD programme across the university has been closely tied to the development of SDL within the ID curriculum and can be used as a framework for competence-centred learning and self-reflection. The ID department has aligned its educational vision and strategy with this programme, embedding SDL into a dedicated P&PD learning trajectory that runs across the bachelor curriculum. Through this integration, students are continuously encouraged to articulate personal goals, reflect on progress, and connect their professional identity development with broader academic and societal challenges (Garrison, 1997).

Stakeholder redesign

The redesign resulted from a co-creative, participatory effort involving a wide range of stakeholders. In line with the official Bachelor College redesign guidelines, the Programme Committee and Student Council, comprising staff and student representatives from different years of the bachelor programme, were involved, together with the Education Management Team (EMT), responsible for curriculum implementation, and the Department Board, overseeing educational innovation, to ensure both academic rigour and a student-centred approach.

Following an initial problem analysis phase, a shared set of design principles for the SDL learning trajectory was formulated and iteratively refined through stakeholder workshops at education days, consultations with various educational committees and student representatives, and quality assurance activities along the implementation process. These principles guided decision making throughout the redesign and ensured alignment across modules and academic years.

Operationalizing SDL

A key challenge in curriculum innovation is translating strategic intentions into coherent educational practice. Within the TU/e ID programme, this required deliberate alignment between educational vision, curriculum design, and operational practices. Coaches and mentors played a central role in supporting students' SDL development, while programme leaders ensure alignment through feedback mechanisms, reflective tools, and structured training activities. Sustaining this alignment involves continuous staff development, evaluation, and iterative refinement.

The curriculum redesign was guided by the principle of 'high alignment, high autonomy', which balances institutional coherence with flexibility at programme and student level. Within this framework, students are given substantial autonomy to direct their learning trajectories, while shared learning outcomes ensure curricular consistency (Binkley et al., 2012). This balance enables diverse learning pathways while maintaining educational quality.

Complementing this principle, 'diversity by design' underpins the department's approach to SDL. Students engage in varied activities, such as design projects, prototyping, research, reflection, and interdisciplinary collaboration, that reflect the multifaceted nature of industrial design practice and provide multiple opportunities to develop SDL competencies through choice and reflection (Gómez Puente et al., 2020).

As a result, SDL at ID is structured around recurring cycles of goal setting, action, feedback, and reflection through the bachelor program. Large-group lectures introduce shared language and frameworks on PI&V, reflection, ethics, expertise development, and portfolio building. These are systematically connected to small-scale student mentor meetings, where students work in consistent groups to translate concepts into PDPs, PI&V, and reflection.

The operationalisation of SDL takes place in a deliberate sequence. In the first year of implementation, student mentoring structures and reflective assignments are designed to support guided goal setting and reflection. In subsequent years, responsibility is progressively shifted to students through freer assignment formats and increased choice in learning activities. Concurrently, coaching roles are redefined to support long-term developmental guidance rather than short-term task supervision.

Individualisation is ensured through regular coach meetings, providing tailored feedback on students' PI&V, competence development, and study choices over time. Skills trainings (e.g., feedback, planning, collaboration, pitching) operationalise professional behaviour through practice rather than abstraction.

Assessment is predominantly formative and portfolio-based, with multiple low-stakes assignments, reflective deadlines, and iterative portfolio updates. The progression from guided reflections to structured assignment cycles, and to portfolio-driven and future-oriented development show a deliberate scaffolding of autonomy. Overall, SDL at ID is enacted as a continuous, mentored professional learning trajectory, tightly embedded in students' education rather than treated as a stand-alone subject.

3.2 P&PD Year 1 development and learning trajectory design

P&PD Year 1 functions as the foundational basis of the P&PD learning trajectory, explicitly designed to introduce first year ID students to structured self-directed learning through a carefully scaffolded trajectory. The development is visible in the sequenced integration of instruction, guided practice, feedback, and increasing learner autonomy, distributed across the academic year.

Orientation and shared terminologies

The year opens with a kick-off lecture on PI&V, immediately positioning personal development as a legitimate and assessable domain of learning. Lectures on documenting process and reflecting at the beginning establish a shared conceptual vocabulary that students will use throughout the year.

Guided socialisation through mentoring

A central element of the trajectory is the recurring bi-weekly student mentor meetings (eight in total). These meetings are deliberately interleaved with lectures and focus on:

- Drafting a PDP;
- Articulating PI&V and future orientation;
- Reflecting on disciplinary knowledge;
- Developing and reviewing a draft portfolio;
- Making informed study choices for Year 2.

Working in stable small groups, students externalise reflection and learn professional dialogue before being expected to be self-regulated more independently.

Individualisation via coaching

Five coach meetings, scheduled at pivotal moments, support individual sense making and developmental steering. These meetings operationalise individualisation by explicitly addressing competence development, PI&V coherence, and learning choices over time rather than discrete module deliverables.

Competencies and skills training as behavioural enactment

Four targeted training sessions (feedback, planning & organising, collaboration, pitching) translate reflective intentions into observable professional behaviour. Their placement after key reflective moments ensures competencies and skills are learned in response to perceived developmental needs.

Formative assessment and autonomy scaffolding

The assessment is embedded through two major reflective deliverables: a reflection mid-year and a portfolio at the end of Quarter 3. The trajectory moves from guided reflection toward portfolio-based synthesis, preparing students for greater autonomy in subsequent P&PD modules.

In summary, P&PD Year 1 is deliberately developed as a high-support, high-structure entry point into SDL. Through repetition, variation, and strategically timed feedback

moments, it establishes the habits, language, and reflective competence required for progressively self-directed professional learning in the following years.

4 Case study: scaffolding students' development in SDL competencies

Central to the development of students' autonomy competencies especially for first-year students is the guidance to become self-directed learners, which we explain in steps. Our students come from very diverse socio-economic and cultural backgrounds, not only from the Netherlands but from all over the world, with a slightly higher number of male than female students. Therefore, training students in professional identity and vision and reflection are core elements of the programme.

In our case study, we show how coaching meetings, assignments, and peer feedback are purposely employed as educational elements aiming at scaffolding the SDL competence development. In addition, through the university Learning Management System (LMS), Canvas, students get access to all the assignments that provide assistance in the content, requirements, and deadlines of the activities. In Example 1, we show how we define one of the assignments, the Personal Development Plan.

Example 1. Personal Development Plan

The Personal Development Plan (PDP) is a framework to support your development. It is a document for planning and directing your competency development on a continuous level, by formulating goals based on your reflection on learning experiences. Formulating goals provides your learning with a direction and makes it possible to evaluate and monitor your progress towards your goals.

The idea is that you use the PDP as a tool to direct your long-term development through formulating a vision on designing (what kind of designer you want to become) and short-term development, describing what do you want to achieve per learning activity. Therefore, you write and adjust your PDP before each coach/mentor meeting in which your study planning and future career is addressed.

A PDP is not a fixed document; you change it along with your development. The deadline in the Canvas assignment is a guideline to support you in guiding your development and prepare your PI&V coach and mentor meetings. You can upload and update your document multiple times during the semester.

TU/e organises its academic year into two semesters, each subdivided into two teaching quarters with distinct module periods and examination blocks, meaning students follow four quarters of modules per year within a semester-based calendar. TU/e ID students need to make choices in Year 2 and 3 based on their own ambition regarding elective modules as well as the Thematic Learning Areas (TLAs) offered at TU/e which allows students to select a set of modules related to a single theme, which, when combined, are part of the self-defined programme of each individual student. TU/e students typically register for modules for Quarter 1 and 2 in late August; registration for Quarter 3 and 4 opens in mid-November. We defined assignments to

support students in choosing their modules. For example, the assignment in Example 2 aims to support students in making choices. The assignments are discussed in groups with the student mentors, so that additional guidance and feedback can be provided.

Example 2. Making choices for Year 2

Goal: make a plan on how to approach making choices for Year 2.

Instructions: prepare a mind map in which you give an overview of the choices you have to make for Year 2. Use the education guide as a source, as well as Canvas, and any other sources you prefer. Make an overview of all the choices that are open to you (that you know of), and what your own choices will likely be (or what you are still doubting between). Why?

Upload the mind map and the overview for this assignment and be prepared to discuss it during the meeting with your student mentor.

Table 4.5.1: Rubrics examples on Reflection on Collaboration for students to self-assess and to receive mentor feedback and summative assessment

Rubrics	*Excellent*	*Good*	*Sufficient*	*Insufficient*
Reflection on collaboration (individual)	In the portfolio, the student reflects on and evaluates their collaboration with peers and external stakeholders (e.g., users, clients, experts). Using examples from Year 1, they assess their contributions, incorporate feedback, and identify areas for improvement.	In the portfolio, the student reflects on their collaboration with peers and external stakeholders, using Year 1 examples to assess their contributions and incorporate feedback.	In the portfolio, the student describes collaboration with peers and external stakeholders, incorporating feedback, but finds it challenging to clearly articulate their own contributions to the learning activities.	In the portfolio, the student does not describe collaboration with peers or external stakeholders, nor their own contributions to the related learning activities, despite the guidance provided.

Finally, in our case study, rubrics also play a prominent role in stimulating SDL. In our case, rubrics serve as a critical instrument not only for summative assessment, but also as a tool for self-assessment and peer feedback, enabling students to monitor and evaluate the development of their own competencies. Table 4.5.1 lists a rubric example on how to reflect on collaboration in Year 1. Beyond student use, rubrics are also employed by mentors, who provide regular feedback on students' progress, and by coaches, who use them to deliver formative feedback that guides further improvement. In this way, rubrics function as a multifaceted assessment framework that supports both evaluation and learning, fostering transparency in expectations and encouraging continuous development of competencies and skills.

5 Evaluation of Year 1

To examine the impact of the P&PD learning trajectory on students' perceptions of SDL, a mixed methods study was conducted among all 159 first year students enrolled in the ID bachelor programme during the 2023-2024 academic year consisting of a survey, focus groups, and semi-structured interviews. The study analysed the P&PD learning trajectory using the curriculum landscape typology (van den Akker, 2003), who distinguishes between three types of curricula: the intended curriculum (what the programme intended to teach), the implemented curriculum (what was actually taught), and the attained curriculum (what students actually learned).

As input for the study, the intended curriculum, as envisioned by the staff, was established through a semi-structured interview, conducted with the programme director, focusing on the vision and objectives of the P&PD learning line. To discover the implemented curriculum interviews with coaches and mentors, complemented by two student focus groups were carried out. The attained curriculum was primarily assessed through a student survey and focus groups, capturing perceived learning gains related to SDL.

The results showed that from the programme management perspective, the intended curriculum aims to develop SDL as a core outcome. Integrated tools and practices have increased students' confidence and readiness for Year 2, although strengthening coherence between content and assignments remains an area for further improvement.

With regards to the implemented curriculum, during the interviews with coaches and student mentors, coaches observed that students are motivated to develop SDL skills but continue to require guidance to sustain their learning. Tools such as portfolios, feedback, rubrics, and reflective activities support this process, although students often need help maintaining an overview of their development. Student mentors indicated that reflection and feedback support self-monitoring and awareness, particularly when links between assignments and programme goals are made explicit. Group coaching stimulates reflection on professional identity, yet first-year students still struggle with articulating this identity, as well as with goal setting and planning, which require continued support.

The survey to establish the attained curriculum combined closed and open-ended questions. Using a standardised instrument, students evaluated training activities across five dimensions: engagement, organisation, feedback, learning atmosphere, and perceived learning gains (five-point Likert scale). Overall satisfaction was rated on a ten-point scale. Open-ended responses on strengths and areas for improvement, together with interview and focus group data, were analysed across the three curriculum levels to provide an integrated understanding of SDL development in the first year of the programme.

In order to explore the students' perceptions of SDL in this part of the study (attained curriculum) in more detail, two student focus groups were conducted to explore experiences and perceptions related to SDL and its key subskills: goal setting, planning, reflection, self-monitoring, and professional identity and vision. The discussions revealed both strengths and areas for improvement in how these competencies and skills are supported within the curriculum. The key themes of student feedback on the attained curriculum are summarised in Table 4.5.2.

Table 4.5.2 Summary of student survey and focus group results

Theme	*Positive points*	*Areas for improvement*
Goal setting	Tools and feedback support goal setting; reflection and questioning help connect assignments and learning goals.	Difficulty translating broad objectives into concrete goals; need for clearer guidance and balance between autonomy and coaching.
Planning	Practical tools and templates help structure planning.	Planning seen as challenging and sometimes disconnected from project work; more early support needed.
Reflection	Portfolio writing and templates stimulate reflection on learning.	Purpose of reflection not always clear; need for earlier introduction, clearer framing, and examples.
Self-monitoring	Feedback and alignment between assignments, competencies, and skills support awareness over time.	Students feel underprepared for ownership early on; gradual increase in coaching and feedback needed.
Professional Identity and Vision	Activities for self-exploration and peer learning are valued.	Difficult to articulate identity early in the programme; need more real-world exposure and role models.

Students stressed the importance of a safe and supportive learning environment for developing SDL skills and expressed a desire for greater flexibility and personalisation in their learning paths. They also noted the need for better integration between lectures, coaching, and mentoring.

Implications for further development of SDL

This analysis suggests that while some learning activities effectively support SDL, particularly in later stages, others require redesign to better activate student engagement and skill development. The progression in perceived value aligns with the broader trend observed in the PI&V learning trajectory: students recognise the importance of these competencies more clearly as they advance in their studies. This suggests a new iteration is needed in the design to improve the different SDL element.

6 Synthesis, implications, and conclusions

This chapter examined how SDL has been embedded within the ID bachelor programme at TU/e through curriculum innovation, with particular attention to the P&PD learning trajectory. Using multiple data sources, student surveys, focus groups, and interviews with coaches, mentors, and programme leadership, the study explored how SDL is intended, implemented, and experienced in practice.

Overall, findings indicate that students recognise the value of SDL and its underlying competencies, including goal setting, planning, reflection, self-monitoring, and professional identity development. However, students consistently emphasised the need for earlier exposure, stronger scaffolding, and better integration of SDL practices across modules, projects, and learning activities. SDL development was most effective when learning activities were clearly connected to assignments and professional goals, supported by timely feedback and opportunities for reflection.

From an implementation perspective, the P&PD learning trajectory plays a critical role in operationalising SDL at curriculum level. Coaches and mentors were essential in guiding students' learning processes, particularly during the early stages when students struggled to articulate goals, plan their learning, and reflect meaningfully on their development. Tools such as portfolios, reflection templates, feedback rubrics, and structured coaching conversations supported SDL development, yet students often need continued support to maintain an overview of their learning progress and to connect individual activities into a coherent developmental trajectory.

A central insight from this study is the importance of balancing structure and autonomy. The ID curriculum design follows a principle of high alignment with institutional goals while granting students significant autonomy to make meaningful choices. Students benefit when expectations are clear yet flexible, allowing them to experiment, revise, and gradually assume responsibility for their learning. Likewise, the principle of 'diversity by design' (As explained in Chapter 3.7) enables multiple learning pathways while maintaining shared programme goals, accommodating the varied interests and learning needs inherent in design education.

Looking ahead, continuous curriculum development remains essential. Future efforts at TU/e ID focus on strengthening longitudinal integration of SDL across the curriculum, increasing coherence between projects, coaching, and assessment practices, and enhancing professional identity development through authentic engagement with industry, societal challenges, and role models. Further refinement of reflective practices, clearer framing of learning objectives, and sustained professional development for coaches will support this ongoing evolution.

In conclusion, developing SDL in engineering education requires more than isolated training activities or standalone tools. It demands a whole-curriculum approach in which SDL competencies are introduced early, reinforced through authentic learning experiences, and supported by consistent coaching and feedback. The experience of the TU/e ID programme demonstrates that when SDL is embedded structurally, through curriculum design, professional development, and change management, students are better prepared to guide their own learning, adapt to complexity, and engage in lifelong professional growth.

7 Key takeaways for practitioners

If you were to set out on a similar journey, we would recommend to:

- introduce goal setting from week 1 using simple SMART style templates students can personalise over time;
- integrate planning directly into project meetings and design reviews so it becomes part of normal engineering workflow;
- use the same rubric for assessment and student self-reflection to reinforce coherence and shared expectations;
- schedule individual or small group coaching sessions every 4 weeks to support autonomy and metacognitive growth;
- provide multiple pathways for SDL development, through varied projects, mentoring, and flexible reflection formats;
- encourage psychological safety by normalising iteration and emphasising reasoning rather than correctness in feedback;
- offer visual summary tables or infographics that break SDL down into subskills (e.g., goal setting, monitoring, reflection) and show concrete ways to apply each in teaching practice.

Within the SEFI handbook framework, the competencies addressed in this chapter align primarily with the category of lifelong learning. The emphasis on self-directed learning, reflection, goal setting, and professional identity development directly supports graduates' capacity to continuously update their knowledge, competencies, and skills throughout their careers. In addition, elements of the P&PD learning trajectory contribute to related transversal competencies, such as self-management, communication, and professional responsibility, illustrating the interconnected nature of these competencies and skills in contemporary engineering education.

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During the preparation of this work, the authors used Microsoft Copilot in order to improve the quality of writing in English and rephrase paragraphs. After using Microsoft Copilot, 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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