3.3

Self-Assessment in Engineering Education

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This chapter presents self-assessment as a practical strategy for learning and professional formation in engineering education. Rather than self-grading, self-assessment is framed as a structured, criteria-based process that helps students monitor their strategies, evaluate their work, and plan improvement. For practitioners, this chapter offers ready-to-use tools, including exam wrappers, reflexive prompts, and developmental rubrics, along with fully worked examples applicable across knowledge-based and design-oriented modules. It addresses common implementation challenges, such as faculty beliefs, time constraints, and student scepticism, and emphasizes rubrics, exemplars, guided practice, and explicit calibration with instructor feedback as essential supports. By embedding self-assessment intentionally, educators can better align technical performance with reflective judgement, professional responsibility, and long-term adaptability.

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1 Introduction: why self-assessment matters

Self-assessment has become an increasingly important practice in engineering education as programmes move beyond viewing it solely as a grading mechanism and adopt more student-centred, outcomes-based approaches (Litzinger et al., 2011; Panadero et al., 2018). Self-assessment is a structured, criteria-based process in which students evaluate their work, monitor their progress, and identify strategies for improvement (Boud & Falchikov, 1989; Yan & Brown, 2017). Because it parallels professional practices such as design reviews, troubleshooting, and performance evaluation, self-assessment connects classroom learning with the reflective, ethical, and technical dimensions of engineering practice (Turns et al., 2014).

When embedded intentionally, self-assessment contributes directly to core transferable competencies and skills identified in the SEFI framework. It strengthens self-regulation by requiring students to monitor their strategies and performance, cultivates self-reflection as they analyse reasoning and feedback, and promotes self-direction by shifting responsibility for improvement from instructor to learner. Structured self-assessment also supports the development of effective learning strategies by helping students replace ineffective habits with targeted approaches to problem solving. It fosters intrinsic motivation by emphasising growth and iteration rather than judgement alone. Through these mechanisms, students calibrate their understanding, respond constructively to feedback, and build habits of intentional improvement (Schunk, 2011). Over time, these practices contribute to professional identity formation, resilience, and adaptability in the face of complex and uncertain engineering problems (Bonilla & Findley, 2024; Trevelyan, 2010). When framed carefully, they can also affirm diverse ways of demonstrating growth, amplify student voice, and promote more equitable participation in engineering classrooms (Nieminen, 2022; Sellers & Villanueva, 2023).

This chapter examines self-assessment in engineering education through three lenses. First, it defines the concept clearly and distinguishes it from related practices such as self-reflection, self-monitoring, and self-evaluation (Yan & Brown, 2017). Second, it explores three core approaches (post-exam self-assessment tools, reflective and reflexive practices, and rubric-based self-assessment) and considers when and why each may be most effective. Third, it discusses practical implementation strategies that support sustainability, alignment, and refinement in diverse engineering contexts (Mannion, 2022; Yucel et al., 2014). In doing so, the chapter illustrates how it functions in practice and demonstrates how you can embed it to strengthen both learning and professional identity formation.

In this chapter, reflection refers to looking back to analyse outcomes, reasoning, or emotional responses, often with the aim of identifying lessons learned and strategies for improvement (Schön, 1983). Reflexivity refers to examining positionality, values, and institutional or social context, with attention to how these factors influence problem framing and design choices (Cunliffe, 2016).

2 Defining self-assessment

Self-assessment is a structured process in which students use explicit criteria to evaluate their work, reflect on their progress, and identify strategies for improvement. At its core, self-assessment requires three elements: clear criteria, evaluative judgement against those criteria, and a feedback loop that informs revision or future action. Without these elements, activities may support reflection, but they do not constitute self-assessment in the sense used here.

Because the term is often used loosely, it is important to distinguish self-assessment from related processes. Terms such as self-reflection, self-monitoring, and self-evaluation are sometimes used interchangeably, yet they serve distinct purposes and vary in their connection to learning outcomes (Panadero, 2017; Taras, 2010). This chapter adopts a focused definition of self-assessment, excluding practices that lack explicit criteria, clear evaluative purpose, or a mechanism for feedback and revision (Boud & Molloy, 2013; Yan & Carless, 2022). Table 3.3.1 summarises these distinctions and clarifies the boundaries of what is included in our use of the term.

Table 3.3.1: Distinguishing self-assessment from related processes and misconceptions

Self-assessment is…	*Self-assessment is not…*
A formative or summative process using explicit criteria to evaluate learning, reflect on progress, and guide improvement (Boud & Falchikov, 1989; Panadero et al., 2018; Yan & Brown, 2017)	Self-grading or self-evaluation used solely to assign a score or judgement, without attention to growth (Andrade, 2019; Taras, 2010)
A cyclical, feedback-informed practice that draws on internal and external sources to support intentional change (Panadero et al., 2017; Yan & Carless, 2022)	A stand-alone self-report or activity disconnected from feedback, revision, or actionable next steps (Bourke, 2018; Yan & Carless, 2022)
A structured comparison of performance against criteria, followed by planning for future improvement (Panadero, 2017; Yan & Brown, 2017)	General reflection or awareness without structure, explicit goals, or evaluative criteria (Bourke, 2018; Taras, 2010)

3 Approaches to self-assessment in engineering education

Self-assessment can take different forms, depending on its purpose, timing, and level of structure. Rather than treating these as competing categories, it is more useful to consider how they complement one another. This section clarifies three distinctions that shape design decisions around self-assessment in engineering modules: process-versus outcome-focused, formative versus summative, and structured versus open-ended approaches.

3.1 Process- and outcome-focused self-assessment

One key distinction concerns whether students are evaluating how they worked or what they produced. Process-focused self-assessment centres on strategies, problem framing, collaboration, and decision making during a task, and is particularly valuable in project- or challenge-based learning where progress unfolds iteratively (Boud & Falchikov, 2007). Outcome-focused self-assessment, by contrast, emphasises the quality of a completed product. Students compare their final work to defined standards, criteria, or exemplars. Although it captures less about the learning process, it strengthens evaluative judgement, an essential professional skill in engineering practice (Tai et al., 2018). In practice, these approaches are most powerful when combined. For example, in a design module, students might keep a reflective journal to examine their problem-solving strategies during the project (process-focused) and later use a rubric to assess their final prototype against professional criteria (outcome-focused).

3.2 Formative versus summative self-assessment

A second distinction concerns timing and purpose. Self-assessment is commonly used for formative purposes, helping students monitor their understanding, analyse progress, and make informed adjustments during the learning process (Panadero et al., 2018; Yan & Brown, 2017). Occurring before final submission, formative self-assessment supports revision by prompting students to identify strengths, diagnose gaps, and adjust their work, often in dialogue with instructor or peer feedback (Black & Wiliam, 1998). However, self-assessment can also serve summative purposes, such as when students evaluate their achievement at the end of a task, module, or milestone as part of a final portfolio or appraisal (Andrade, 2019). Even in these contexts, it remains developmental when students justify their evaluations and articulate next steps for improvement. For instance, students in a laboratory module might complete a mid-semester self-review to refine experimental techniques (formative) and later write a final self-assessment reflecting on their growth across the term (summative). The critical distinction, therefore, lies less in whether the task contributes to grading and more in whether it fosters evaluative judgement and forward-looking improvement.

3.3 Structured and open-ended approaches

Self-assessment also varies in its degree of scaffolding. Structured approaches, such as rubrics, checklists, or rating scales, provide explicit criteria and a consistent framework for judgement (Panadero & Jonsson, 2013). These tools are especially useful in large modules or multi-instructor settings, where transparency and alignment are priorities. Open-ended self-assessment, such as journals and reflective narratives, allow students to explore their reasoning and experiences in their own words. While they can bring deeper insights to light, they often require guidance to ensure that reflection moves beyond description toward evaluation and planning (Wallin & Adawi, 2018). In a capstone modules, for example, students might use a rubric to assess technical criteria (structured) and write a brief reflection on team dynamics or design trade-offs (open-ended).

Table 3.3.2: Approaches to self-assessment in engineering education

Approach	*What it is*	*When you might use it*
Post-exam self-assessment tools	Structured activities after exams that prompt students to analyse their preparation, identify error patterns, and plan specific improvements (e.g., exam wrappers, guided error analysis) (Panadero et al., 2017; Yucel et al., 2014).	Particularly effective in exam-based modules (e.g., statics, circuits, thermodynamics) where you want students to move beyond grades to diagnose misconceptions, refine study strategies, and build resilience (Yan & Brown, 2017; Zimmerman & Schunk, 2011).
Reflective and reflexive practices	Prompts or assignments that require students to examine their learning processes, reasoning, assumptions, and the broader context of engineering decisions (e.g., reflective writing, reflexive memos) (Bourke, 2018; Turns et al., 2014).	Most effective in project- and design-based modules where technical, ethical, and social dimensions intersect and where adaptive expertise and professional identity are central learning goals (Nieminen, 2022).
Rubric-based self-assessment	Developmental rubrics with explicit criteria and performance levels that prompt students to evaluate their work, justify ratings, and identify next steps (Panadero et al., 2018).	Useful across knowledge-based and process-oriented modules, especially where transparency, alignment with competencies, and iterative improvement are priorities (Mannion, 2022; Yucel et al., 2014).

4 Implementation in engineering programmes

The impact of self-assessment depends less on the concept itself and more on how it is designed, scaffolded, and embedded in a course. This section translates the preceding distinctions into practical approaches that you can adopt and adapt. It highlights three complementary approaches commonly used in engineering education: post-exam self-assessment tools, reflective and reflexive practices, and rubric-based self-assessment. Each serves a distinct purpose and aligns with different module structures, assessment types, and professional competencies. Rather than treating these as alternatives, they can be combined strategically across a programme. Together, they support the development of self-regulation, self-reflection, self-direction, learning strategies, and autonomous motivation, while also strengthening technical judgement and professional responsibility. Table 3.3.2 provides an overview of each approach and when it may be most effective.

These approaches are also feasible in large cohorts (e.g., 150-250 students) when they are designed to minimise additional marking and administrative burden. For example, exam wrappers and brief reflective activities can be implemented using standardised prompts and structured response templates, and assessed using low-stakes, completion-based credit focused on the presence of a concrete action plan rather than the quality of the narrative. Similarly, rubric-based self-assessment can remain manageable when students are asked to self-rate only selected criteria and provide brief, evidence-based justifications, while you calibrate expectations through exemplars and periodic sampling or spot-checking of submissions. Peer-supported processes (e.g., structured peer assessment aligned to the same rubric) can further distribute feedback work, allowing instructor input to focus on recurring patterns and targeted whole-class guidance. Where available, learning platforms can support efficient collection, aggregation, and analysis of responses, enabling you to provide feedback at the level of common needs rather than extensive individual commenting.

4.1 Post-exam self-assessment tools

Exams in engineering education are often treated as final checkpoints, i.e., summative assessments marking the end of a learning unit. When paired with structured follow-up activities, however, they can become powerful learning events. Post-exam self-assessment tools invite students to revisit their performance, analyse patterns of error, and identify specific strategies for improvement. In doing so, they shift attention from "*What grade did I receive?*" to "*What does this performance reveal about how I prepared and how I should adjust?*" This shift supports self-regulation by prompting students to monitor their strategies, strengthens learning strategies by making preparation habits explicit and revisable, and fosters autonomous motivation by framing mistakes as data for growth rather than evidence of fixed ability. In a discipline where iteration and troubleshooting are central, post-exam reflection mirrors professional engineering practice.

Post-exam tools in action

Post-exam self-assessment can be brief and low-stakes or more structured and analytical. Three adaptable approaches are described here.

Exam wrappers. Exam wrappers are short reflections completed after an exam. They prompt students to examine how they studied, identify recurring error types, and commit to specific changes before the next assessment. For example, in thermodynamics, wrappers can help students recognise that memorising equations is insufficient for solving multi-step problems which require identifying system boundaries, applying conservation principles, and interpreting property tables. This realisation often leads students to shift away from passive review to targeted problem-solving practice.

Guided reflection prompts. Guided prompts move beyond right-wrong analysis by asking students to examine their reasoning. Typical questions include "*Where did your reasoning diverge from the expected approach?"*, "*What misconception influenced this answer?"*, and "*How would you approach a similar problem differently?"* Such prompts are most effective in modules where conceptual reasoning and problem framing are central, such as statics, circuits, mechanics, or systems modelling. They are particularly useful when you want students to explain why an approach was flawed rather than simply identify that it was incorrect. By emphasising explanation over categorisation, guided reflection strengthens evaluative judgement and disciplinary thinking, while also strengthening students' ability to articulate reasoning in collaborative engineering contexts.

Error typologies. Structured error analysis asks students to categorise mistakes (e.g., conceptual misunderstanding, misreading, calculation error, time management) and identify likely causes. Unlike exam wrappers, which prompt broad reflection on preparation strategies, error typologies focus specifically on diagnosing patterns within the exam itself. They are most effective when you observe recurring misconceptions or want students to distinguish between surface errors and deeper conceptual gaps. In a digital systems module, for example, students may initially label errors as 'calculation mistakes', only to realise the root cause was misinterpreting constraints or working under time pressure. Recognising these distinctions enables more targeted preparation and reinforces a key professional norm: engineers diagnose underlying causes, not just outcomes. Error typologies are especially useful in large, exam-heavy modules where you want structured insight into common errors across cohorts.

A worked example from practice

In a second-year statics and dynamics module (approximately 50 students), the third author introduced structured exam wrappers after the first midterm. Historically, students attributed poor performance to vague explanations such as 'careless mistakes' or 'not enough revision'. The wrapper was designed to prompt specific diagnosis and planning. Students completed the reflection during the first ten minutes of the next class and received completion credit (2% of the module grade). Two weeks later, they submitted brief evidence of one strategy they had implemented (e.g., annotated practice problems or a revised study plan). Their responses were analysed for recurring patterns, and part of the next class session was devoted to addressing the three most common misconceptions. Within two exam cycles, students' plans became more specific, fewer attributed performance to fixed ability, and preparation strategies aligned more closely with the cognitive demands of exam questions.

Example 1. Post-exam reflection template

This example fits early-stage undergraduate, exam-based engineering modules (e.g., first- or second-year statics, circuits, thermodynamics) where you want students to use exam performance to diagnose misconceptions and adjust study strategies before the next assessment.

1. Two types of errors I made most frequently:
- ❑ *conceptual misunderstanding*
- ❑ *misreading the question*
- ❑ *calculation error*
- ❑ *time management*
- ❑ *other: _______________*

2. Example and root cause:
- ❑ *on what question did you make an error? (Select one.)*
- ❑ *what specifically went wrong?*

3. How I prepared for this exam (mark all that apply):
- ❑ *reread notes*
- ❑ *solved practice problems*
- ❑ *studied with peers*
- ❑ *other: _______________*

4. One strategy that did not work well — explain why.

5. One strategy I will change before the next exam — be specific.

6. One resource I will use, e.g., office hours, tutoring, study group.

This structure can be readily adapted to other exam-based modules (e.g., circuits, mechanics, materials) by tailoring the error categories, prompts, and follow-up expectations to align with local learning goals and assessment formats.

Embedding post-exam self-assessment effectively and equitably

Students' exam experiences are shaped by prior preparation, cultural expectations, and access to support systems (Yan & Carless, 2022). Without careful framing, reflection activities may reinforce deficit narratives or fixed-ability beliefs, particularly when performance is interpreted as a signal for who is 'cut out' for engineering (London et al., 2011; Tonso, 2006). Post-exam self-assessment should therefore position mistakes as a normal and expected part of learning and professional engineering practice. Just as design involves testing, iteration, and revision, exams can be reframed as part of that same developmental cycle.

Post-exam self-assessment tools are most effective when they promote equity while also informing both student action and instructional decisions.

To support student learning and equitable participation, you can:

- Normalise error as expected in engineering practice;
- Model reflective thinking by analysing a common mistake and demonstrating a revision (Metcalfe, 2017);
- Invite contextual reflection, allowing students to note factors affecting preparation (e.g., workload, employment, access to study space) (Bang & Vossoughi, 2016);
- Require specific, feasible action before the next assessment, not general intentions, to ensure reflection leads to action;
- Include a brief follow-up checkpoint to reinforce implementation;
- Emphasise improvement rather than performance alone, for example by grading for completion rather than accuracy and allowing private submission.

To strengthen instructional practice, you can:

- Review reflections for recurring misconceptions or strategy gaps;
- Share patterns with the class and adjust instruction accordingly;
- Periodically revisit exam format, pacing, or feedback, if misalignment persists.

When embedded consistently, post-exam reflection cultivates an iterative learning culture. Students learn to analyse mistakes and implement changes; you gain insight into student thinking, and exams become part of a developmental cycle rather than isolated endpoints.

4.2 Reflective and reflexive practices

Project- and design-based modules are well suited for reflection and reflexivity because students must collaborate, make decisions under uncertainty, and justify trade-offs in ways that resemble professional engineering work. When structured intentionally, these practices help students improve their technical decision making and examine how values, assumptions, and context shape design outcomes (Kim et al., 2019). As a result, reflection and reflexivity can strengthen adaptive expertise, helping future engineers navigate ambiguity while remaining ethically and socially aware (Fisher & De Rosa, 2021).

Distinguishing reflection and reflexivity

In this chapter, reflection refers to looking back to analyse outcomes, reasoning, or emotional responses, often with the aim of identifying lessons learned and strategies for improvement (Schön, 1983). Reflexivity refers to examining positionality, values, and institutional or social context, with attention to how these factors influence problem framing and design choices (Cunliffe, 2016). Reflection supports metacognitive growth and technical learning, while reflexivity presses students to ask why they approached a problem in a certain way and how their assumptions or biases shaped outcomes. Research shows that engaging in both practices consistently and with purpose helps students articulate their learning and take ownership of their growth (Thomson & Kövesi, 2023).

Embedding reflection and reflexivity into modules

Reflection and reflexivity can be embedded through activities that help students examine their learning processes and the broader contexts of their work. Together, reflection and reflexivity foster a more complete form of learning that advances technical competence while cultivating ethical responsibility, social awareness, and professional identity development (Hirsbrunner et al., 2024). The following strategies describe how these practices can surface insights, challenge assumptions, and connect technical decisions to ethical and social considerations in engineering:

Reflective writing prompts. You can use guided prompts in design- and project-based modules to help students surface implicit assumptions, connect disciplinary values to broader societal needs, and develop technical discernment over time (Cosgrove, 2022). For example, you can ask for weekly reflections in a capstone module in which students (1) identify key moments of insight, tension, or challenge; (2) explain how their thinking evolved or was challenged during the project; and/or (3) connect module content to prior experiences and personal beliefs.

Reflexive memos. You can use reflexive memos to ask students to examine a specific design decision by identifying the assumptions and disciplinary norms that shaped it and considering the consequences for different stakeholders (Boyd, 2023). If you integrate these memos at key project milestones, you can strengthen students' capacity to recognise and engage with the social justice dimensions of engineering work, supporting them to become more socially responsive practitioners (Boyd, 2023; Nelson et al., 2024). For instance, in a biomedical engineering module, you can ask students designing a portable insulin delivery device for children to reflect on how assumptions about a 'typical' child user shaped their design, how values influenced trade-offs between cost, reliability, and comfort, and how prototype feedback revealed overlooked perspectives that led them to revise their decisions.

Grade for specificity and insight, not for virtue or personal disclosure. In your grading, reward clear evidence, explicit articulation of assumptions, and concrete changes to the design or process. Explicitly state that students will not be evaluated on the perceived 'correctness' of their values or feelings — i.e., their 'virtue' —, but on the quality of their reasoning and the way they use reflection to improve decisions.

Deepening reflexivity: examining assumptions and decisions

While these strategies provide accessible entry points, you can help students develop deeper reflexivity by explicitly examining the assumptions that shape their decisions. Reflection is most powerful when treated as a practice of meaning-making, asking not only what happened, but why choices were made and whose perspectives they represent (Figard & Mercado, 2023). One framework that supports this deeper engagement is Sochacka et al.'s (2009) three-tier model of reflexivity, originally developed for engineering education research but easily adapted for student projects. It prompts learners to (1) examine their ontological and epistemological assumptions by asking what counts as knowledge and who has the authority to define it; (2) acknowledge the influence of personal values by situating practice in broader social, institutional, and historical contexts; and (3) reflect on how prior experiences shape their choice of methods and tools.

Applied in design modules, this framework helps students recognise how decisions about 'good' usability may rely on hegemonic norms or how trade-offs (e.g., cost vs. accessibility) reflect assumptions about the 'typical' user. Mapping design choices back to these tiers allows learners to gain insight into how positionality shapes the engineering process. Cunliffe (2016)'s concept of 'critical reflexivity' deepens this stance by emphasizing the ongoing, disruptive questioning of how engineers come to know, think, and act. When projects involve community stakeholders, sustainability goals, or global development challenges, the stakes of unchecked assumptions become especially high (Cain et al., 2023).

Implications for engineering education

Reflection and reflexivity function as critical forms of self-assessment within engineering project and design modules. Activities such as guided writing or reflexive memos ask students to evaluate how their perceptions, values, and decisions shape their work. When learners articulate what informed a technical choice, they are assessing their own mental models and the guiding principles that shaped their reasoning (Olewnik et al., 2024). This process helps students surface unconscious biases, refine problem framing, and consider the broader social implications of their designs. Over time, they develop the metacognitive skills needed to address ill-structured engineering problems (Marra et al., 2022; Wengrowicz et al., 2018), the capacity to judge their own reasoning, adjust assumptions when evidence or ethics demand it, and approach future projects with a more reflexive mindset. Over time, reflective and reflexive practices support stronger problem framing and growth as thoughtful, socially responsive engineers equipped for lifelong professional learning (Fisher & De Rosa, 2021; Kim et al., 2019).

4.3 Rubric-based self-assessment

Rubric-based self-assessment can strengthen learning when they are used as tools for guidance and revision, instead of solely as scoring sheets. By making expectations explicit, rubrics help students judge their current work against shared criteria, identify what to improve, and plan concrete next steps (Boud, 1991). This is especially useful in project and active-learning settings for connecting conceptual knowledge with professional competencies (Dochy et al., 1999). In general, rubrics align well with engineering practice, where progress is iterative, feedback-rich, and tied to professional standards.

From outcomes to developmental growth

Traditional assessments can signal performance as a final verdict, which makes it harder for students to see how improvement happens. Rubric-based self-assessment addresses this by describing progress as a continuum (e.g., Beginning, Emerging, Proficient, Advanced) and making growth visible over time. When students use the same rubric repeatedly across assignments or iterations, they can track change, set goals, and build motivation through evidence of progress. In engineering, this approach mirrors professional practice because engineers routinely evaluate work against criteria, identify gaps, and revise based on feedback.

Rubric-based self-assessment practices

The following practices describe how rubrics can support progress monitoring, align evaluation with learning goals, and connect student development to professional competencies in engineering:

Tie the rubric directly to learning goals and show how it will be used. Align criteria with the outcomes students are expected to demonstrate and refer to the rubric during instruction, not only at grading time. For example, in a knowledge-based master module, criteria might assess students' ability to apply theoretical concepts to real-world scenarios, emphasizing integration of knowledge, critical analysis, and application in societal contexts. In a project module, criteria can emphasize decision-making process, stakeholder reasoning, and iteration. In both cases, rubrics serve as scaffolds that help students frame their reflections and connect performance to broader module goals.

Treat the rubric as a tool for tracking progress across time. Use the same rubric at multiple points in a project or across several assignments and ask students to identify one criterion they improved and one they will target next. This shifts the rubric from a one-time evaluation to a developmental record of learning. Research further shows that when students engage with rubrics consistently and with purpose, they are better able to reflect on their development and take greater ownership of their progress (Panadero & Jonsson, 2013). In a knowledge-based module, for instance, students might begin by acknowledging gaps in understanding but gradually articulate greater confidence in applying theoretical frameworks and critically evaluating their work. In project-based modules, reflections may reveal more dynamic and nonlinear trajectories, as students adapt strategies through experimentation, feedback, and shifting roles within teams.

Justify decisions and learn from feedback. Rubrics are most powerful when students are required to justify their ratings rather than simply selecting a level (Andrade & Valtcheva, 2009). Providing evidence from coursework, projects, or team interactions fosters metacognitive awareness by prompting students to analyse strategies, recognise progress, and plan next steps. In knowledge-based modules, students might justify their ratings by explaining how they applied theoretical frameworks and evaluating their effectiveness. In project-based modules, justifications are often narrative, including reflections on teamwork, stakeholder engagement, and professional identity development.

A worked example from practice

In several project-based modules (all with approximately 35 students), the first author introduced rubric-based self-assessment. Students assessed themselves several times during the module based on their development on the module's learning objectives. This self-assessment consisted of completing a rubric and writing a short justification. The rubric could be scored on process-based levels, see also Example 2. Interviews with students showed that this process allowed them to take ownership of their own learning and helped them understand what to do to further develop their skills.

Example 2. Rubric-based self-assessment

This example illustrates how a developmental rubric can guide student self-assessment in project-based engineering modules. Students use the rubric multiple times to evaluate how their reasoning, collaboration, and decision-making evolve over time.

This example fits mid- to late-stage undergraduate project and design modules where teamwork and iterative decision making are assessed over multiple milestones; it can be adapted for master-level project modules with similar iterative cycles.

Each criterion includes multiple developmental levels that are consistent with growth-oriented assessment approaches. Students are asked to (1) select the level that best represents their current performance; and (2) provide a short justification for why they chose that level. Instructors require students to revisit the same rubric later in the project. Students highlight shifts in their level (e.g., Emerging → Proficient) and explain what supported that growth.

Table 3.3.3: This table shows the levels for the learning goal "Students are able to communicate and collaborate with people from other disciplines".

Beginning	Emerging	Proficient	Advanced
I mostly communicate from my own disciplinary perspective, and I struggle to explain ideas in ways others can easily follow. *I often need help noticing or resolving communication challenges.*	*I am starting to adjust my language so teammates and stakeholders can understand me.* *I can spot communication challenges, but I'm not yet consistent in addressing them.*	*I communicate clearly across disciplines and adapt my wording to fit different audiences.* *I collaborate effectively, understand others' contributions, and address communication issues constructively.*	*I anticipate communication challenges and tailor my approach to different disciplines and stakeholders.* *I help the team align perspectives and support others in navigating complex communication situations.*

Embedding rubric-based self-assessment into modules

Rubric-based self-assessment can be embedded through activities that help students evaluate their development over time and make sense of their learning. When framed developmentally, rubrics offer students a clear pathway for growth and help them connect their ongoing work to broader professional competencies. These practices foster metacognition, strengthen evaluative judgement, and support the formation of self-directed learning habits. The following strategies illustrate how rubric-based self-assessment can guide students in identifying progress, planning next steps, and engaging more deeply with engineering learning:

Use developmental levels aligned with module timepoints. Developmental labels such as 'Beginning', 'Emerging', 'Proficient', and 'Advanced' help students understand that growth occurs across the duration of a module rather than at a single evaluative moment. Asking students to self-assess at multiple points (such as early in a project, mid-module, and at the end) helps them recognise patterns, articulate shifts in their thinking, and plan targeted improvements.

Incorporate multiple measures to make growth visible. Providing repeated opportunities to complete the same rubric encourages students to track changes in their approach, strategies, and confidence. Multiple measures also allow you to track how students perceive their learning with what is demonstrated in their work, supporting more accurate self-evaluation and helping students develop stronger metacognitive awareness.

Embed a feedback loop on completed rubrics. When students submit rubrics alongside their work, you can respond to both the product and the student's interpretation of their progress. Brief comments, discussion prompts, or calibration conversations help students refine the understanding of their growth and development over time. This feedback loop reinforces rubric use as part of an ongoing learning cycle rather than a stand-alone activity.

Rubrics can clarify expectations, but they can also unintentionally privilege narrow forms of demonstration if descriptors are vague or rely on implicit norms. Students from diverse backgrounds may interpret vague descriptors differently or feel constrained if criteria privilege narrow ways of demonstrating knowledge. Clarity of descriptors is therefore essential; concrete examples at each level help students see what performance looks like in practice (Jonsson & Svingby, 2007). Alignment with module goals is equally important. Present the rubric as a guide for improvement and invite multiple forms of evidence for meeting criteria, especially in process-oriented outcomes such as collaboration, communication, and design reasoning. Making expectations explicit in this way supports students who may otherwise be disadvantaged by hidden curricula (e.g., first-generation students) (Garriott & Nisle, 2018; Sellers & Villanueva, 2023).

Supporting reflection is another key consideration. Structured prompts, examples, and timely feedback help students move beyond surface-level observations toward deeper analysis (Boud & Molloy, 2013). At the same time, you must manage practical challenges such as workload and calibration. Because reviewing self-assessments can be time-intensive, digital tools and peer feedback can help sustain the practice while ensuring students receive guidance. Calibration activities, such as co-creating rubrics or reviewing sample reflections, not only improve reliability but also engage students as partners in the process, reinforcing equity and ownership. When rubrics are designed with these considerations in mind, they support accurate and meaningful self-assessment while also fostering belonging, affirming diverse strengths, and cultivating the reflective habits needed to thrive in engineering education and practice.

Implications for engineering education

Rubric-based self-assessment functions as a critical tool for supporting learning and professional formation. By evaluating their progress against clearly defined criteria and justifying their ratings with evidence, students engage in metacognitive practices that help them recognise patterns in their thinking, refine problem-solving strategies, and plan concrete next steps (Andrade & Valtcheva, 2009). This process fosters resilience and adaptability, encouraging students to view learning as iterative rather than fixed, while also connecting academic assessment to professional competencies such as collaboration, stakeholder engagement, and ethical responsibility. For you as educator, rubrics provide diagnostic insight into how students interpret expectations and respond to feedback, making implicit standards explicit and supporting more equitable learning environments (Jonsson & Svingby, 2007). Over time, consistent use of rubric-based self-assessment cultivates both technical competence and the reflective habits of mind necessary for adaptive expertise, positioning engineering students to grow as accountable, socially responsive professionals prepared for lifelong learning (Brookhart, 2013; Panadero & Jonsson, 2013).

5 Implementation considerations

While self-assessment offers clear benefits, effective implementation requires intentional design. Students may resist these activities if they perceive them as peripheral to technical work or unclear in purpose. Concerns about judgement, confidence, or accuracy can further shape participation. Research consistently shows that novices tend to overestimate performance, while stronger students may underestimate it, underscoring the need for calibration and guided practice (Dunning & Kruger, 1999; León et al., 2021).

You may face parallel challenges, including time constraints, grading pressures, and uncertainty about how to scaffold reflective practices effectively. Your own beliefs as an instructor also influence student uptake, with some viewing self-assessment as central to professional formation, while others question its reliability or instructional value (Andrade, 2019; Yan, 2020). These realities highlight a central principle: self-assessment must be explicitly aligned, scaffolded, and embedded within feedback cycles to be meaningful.

Table 3.3.4 summarises how the approaches discussed in this chapter contribute to selected competencies and what observable evidence you might expect in practice.

Drawing on both research and practice, the following considerations outline strategies for embedding self-assessment in engineering modules.

Align self-assessment with module goals. Self-assessment is most effective when clearly tied to learning objectives. Prompts and rubrics should reflect the language and priorities of the module, so students recognise them as integral rather than peripheral. For example, in thermodynamics or circuits, an exam wrapper might ask students to identify where and why points were lost, linking errors to specific conceptual gaps. In an environmental engineering capstone, a reflexive memo might require students to move beyond listing sustainability factors and instead analyse how material, energy, and disposal considerations interact within a broader system. In both cases, alignment reinforces authenticity and professional relevance.

Table 3.3.4: Self-assessment and relevant competencies

Competency	*How self-assessment develops it*	*Observable evidence in modules*
Self-regulation	Students monitor strategies, diagnose errors, and plan concrete improvements (e.g., through exam wrappers and rubric-based review).	Students identify specific learning gaps and submit action plans; improved strategy use over time.
Self-reflection	Structured prompts and reflexive memos require students to articulate reasoning, assumptions, and growth.	Written reflections that identify strengths, limitations, and revised approaches.
Self-direction	Repeated self-assessment tasks shift responsibility for improvement from instructor to student.	Students set learning goals, track progress across milestones, and independently seek resources.
Autonomous motivation	Emphasizing growth and iteration reframes assessment as development rather than judgement.	Increased persistence after setbacks; reflective planning rather than grade-focused responses.
Learning strategies	Post-exam tools and rubric use make study and problem-solving strategies explicit and revisable.	Students replace ineffective strategies (e.g., cramming) with targeted practice and planning.

Scaffold for accuracy and engagement. Self-assessment is a skill that develops with guided practice. Rubrics, exemplars, and modelling help students learn what evaluative judgement looks like before applying it independently. In exam-based modules, you can model wrapper completion by analysing a sample solution and demonstrating how to diagnose reasoning breakdowns. In design-based modules, students may begin with structured reflexive prompts and gradually move toward more independent reflection. Similarly, rubric-based self-assessment benefits from calibration exercises, such as comparing self-ratings with instructor feedback and discussing discrepancies. Scaffolding should therefore involve modelling, structured examples, and iterative feedback, not simply providing answers.

Integrate self-assessment with instructor feedback. Self-assessment complements, rather than replaces, instructor feedback. Asking students to submit reflections or rubric ratings alongside their work creates opportunities for calibration and dialogue. For example, a student reviewing a statics exam may express confidence in free-body diagrams but identify difficulty with combined loading; instructor feedback can clarify assumptions and direct targeted practice. In design contexts, persona development may reveal overlooked user groups, prompting discussion about broader stakeholder needs. When self-scores and instructor scores diverge, structured discussion supports accuracy and shared standards. Embedded with a feedback cycle, self-assessment strengthens evaluative judgement and reinforces that improvement, not self-judgement, is the goal.

6 Conclusions: toward a culture of reflective growth

Self-assessment is more than an instructional technique; it is a practice that shapes how engineers learn, adapt, and develop. When intentionally designed, it helps students evaluate their work honestly, recognise strengths and limitations, and treat feedback as a resource for improvement rather than judgement. Over time, these habits strengthen self-regulation, reflective judgement, and strategic learning, capabilities that prepare students for professional practice.

Beyond individual assignments, self-assessment links learning to identity formation and social responsibility. By asking students to articulate their reasoning and growth, it reinforces agency and acknowledges that competence develops through iteration. Framed carefully, self-assessment can also support equity and belonging by positioning growth, not innate ability, as central to engineering success.

The challenge is not whether to use self-assessment, but how consistently and intentionally to embed it. When integrated across modules through post-exam tools, reflective practices, and rubric-based evaluation, it becomes a part of the learning culture rather than an add-on activity. In this way, reflection, calibration, and feedback literacy stand alongside technical mastery as defining features of what it means to think and act as an engineer. Embedded within curricula and supported by thoughtful design, self-assessment extends beyond a method of evaluation to become a foundation for sustained professional growth.

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