

The Role and Significance of Skills in Working with Online Platforms in Engineering Education

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Abstract: Engineering education is rapidly transitioning toward hybrid and fully online models in response to the digitalization of industry and the growing demand for flexible learning. In this context, the ability of engineering students to work productively with online platforms—learning management systems, virtual laboratories, collaboration suites, and assessment tools—has become a foundational professional competence rather than a peripheral add-on. This article conceptualizes “skills in working with online platforms” as a compound of technological fluency, academic digital literacy, collaborative problem-solving, data ethics and security awareness, and self-regulated learning. Drawing on established pedagogical frameworks and engineering accreditation logics, it explains how such skills support core outcomes including problem analysis, design, teamwork, and lifelong learning. The study proposes an implementation model that embeds platform skills into the curriculum through scaffolded design tasks, authentic assessments, and virtual experimentation aligned with professional standards. It outlines methodological considerations for evaluating impact, emphasizing triangulated evidence from learning analytics, performance artifacts, and learner self-regulation indicators. Results synthesized from the literature and practice suggest that integrated development of platform skills enhances engagement, increases the quality of design documentation, strengthens collaboration in distributed teams, and supports equitable access to laboratory-like experiences via online or remote labs. The paper concludes with implications for program leaders and instructors, highlighting the need for coherent policy, faculty development, and assessment rubrics that value process and professional conduct in digital spaces alongside technical outcomes.

Keywords: Engineering education; online platforms; virtual labs; digital literacy; collaboration; assessment; ABET outcomes.

Introduction: Engineering practice has long relied on digital workflows, distributed teams, and standardized data exchange. As industry 4.0 accelerates, the instructional environments that prepare future engineers must similarly operate through digital platforms. In such settings, platforms are not merely containers for content; they are the authentic medium through which engineers coordinate design work, run simulations, track requirements, document versions, and present evidence for decisions. Consequently, student proficiency with online platforms underpins the acquisition and demonstration of engineering competencies. The relevant skills blend technical navigation with purposeful academic action: selecting appropriate tools, structuring collaboration, negotiating version control, adhering to ethical and

cybersecurity norms, and maintaining traceable documentation that can be reviewed and audited.

A robust conceptualization aligns these abilities with well-known pedagogical perspectives. Interaction theory frames platforms as enabling learner–content, learner–instructor, and learner–learner exchanges that carry distinct cognitive and social functions. TPACK emphasizes the interplay between technology, pedagogy, and disciplinary content knowledge, implying that platform skills are meaningful only when they serve the epistemic practices of engineering rather than generic tool use. Active learning research, meanwhile, links well-designed digital tasks to increases in conceptual understanding and retention. Accreditation criteria such as those of ABET further foreground outcomes related to experimentation,

communication, teamwork, and ethical responsibility, all of which must be performed and evidenced in digital spaces. These perspectives converge on a single point: without explicit cultivation of platform skills, the intended learning outcomes of modern engineering curricula are difficult to reach and even harder to demonstrate.

The article proposes a design-based approach for embedding platform skills into engineering courses and for evaluating their effects on learning. The implementation centers on a coherent sequence that maps targeted competencies to authentic engineering activities. In the early stage, students are oriented to the platform's affordances for planning, collaboration, and documentation, but the orientation is tied immediately to a practical design or analysis task to keep instruction purposeful. As learners progress, tasks require increasingly sophisticated use of analytics dashboards, version histories, virtual instruments, and standards-compliant file formats. Security and data ethics are integrated across tasks rather than treated as a separate topic, so that students demonstrate responsible conduct while working with real-world constraints such as confidentiality, traceability, and reproducibility.

Evaluation follows a triangulated methodology. First, learning analytics from the platform capture indicators of self-regulation and collaboration, such as temporal patterns of engagement, contribution balance within teams, and responsiveness to feedback cycles. Second, performance artifacts—design reports, code repositories, simulation outputs, and lab notebooks—are judged using rubrics that reward both engineering correctness and professional digital practice, including clarity of versioning, adequacy of metadata, and replicability of results. Third, reflective instruments gauge learner perceptions of efficacy, workload management, and ethical awareness. In capstone or upper-division settings, instructors may include virtual or remote laboratories conforming to recognized standards to strengthen the link between platform work and experimental competence. The resulting data set enables both formative adjustments in course delivery and summative judgments about program-level attainment.

When platform skills are taught as integral to engineering tasks, several measurable improvements typically emerge. Engagement becomes more evenly distributed over time as students develop routines for planning and incremental documentation rather than concentrating effort immediately before deadlines. This shift correlates with clearer articulation of problem statements and better-structured design rationales because learners can trace decision points

through comments, commits, and notebook entries. Collaborative deliverables improve in coherence and accountability once teams internalize shared conventions for naming, branching, and review, and once they experience how unresolved conflicts and undocumented changes hinder collective progress. Instructors report a more transparent window into the learning process, allowing feedback to target underlying misconceptions instead of superficial presentation issues.

Virtual and remote lab components, delivered through standards-aware platforms, further expand opportunities. Students who might otherwise have limited access to specialized equipment can conduct parameter sweeps, repeat measurements, and compare configurations within a controlled environment that records inputs and outputs systematically. This repeatability fosters experimental discipline, as learners must plan procedures, justify ranges, and evaluate uncertainty rather than execute a single unrepeatability trial. Equally important, the laboratory notebook embedded in the platform becomes a living record that aligns with modern industry expectations around traceability and quality management.

Assessment practices benefit from the visibility and granularity of digital evidence. Rubrics can recognize constructive collaboration, ethical handling of data, and communication clarity alongside technical accuracy, giving students a broader incentive structure that reflects professional practice. Because the artifacts exist in versioned form, instructors can differentiate between conceptual breakthroughs and cosmetic polishing, and students can receive feedback on the process, not only the final state. Longitudinally, programs can analyze aggregates of platform data to identify bottlenecks in curricula where students struggle with particular forms of modeling, documentation, or coordination, enabling targeted interventions such as short workshops or redesign of prerequisite tasks.

The development of platform skills also interacts positively with equity and inclusion. Clear conventions, asynchronous collaboration tools, and recorded walkthroughs reduce the penalty for students who are balancing work, caregiving, or variable internet access. When tasks are designed to support multiple modalities of contribution—drafting requirements, building a test bench, curating datasets, or synthesizing results—team success no longer depends on a single dominant channel of performance. Ethical instruction embedded within platform use raises awareness about privacy, intellectual property, and responsible AI, anchoring a professional identity that values safety and

societal impact in addition to innovation.

Potential challenges do arise. Overemphasis on the platform itself can produce tool-centrism if instructors conflate navigation with understanding. Mitigation requires that every platform action be justified pedagogically: a version control step should serve design traceability; a dashboard glance should support validation against specifications. Another challenge concerns cognitive load. Rich platforms present many features, and novices may struggle without carefully staged scaffolds. Instructors should therefore introduce features in sync with task complexity and provide immediate opportunities to apply them in context. Finally, reliable access and support must be secured, including clear policies for data retention, academic integrity in digital submissions, and accommodations for outages.

Evidence from multiple implementations suggests that the more intentionally platform skills are woven into core engineering assignments, the more they accelerate progress toward program outcomes. Design reports demonstrate stronger argumentation as students cite simulation results and link back to annotated requirements. Experimental write-ups show improved internal validity as procedures are pre-registered within the platform's templates and deviations are documented. Communications to external stakeholders become more professional because platforms naturally require concise, audience-aware messaging in tickets, comments, and sprint reviews. Most notably, students begin to perceive platform skills as part of their professional identity, carrying these practices into internships and early career roles where distributed collaboration and disciplined documentation are the norm.

Online platforms are now the operational fabric of engineering learning and practice. Treating skills for working with these platforms as central competencies rather than peripheral utilities aligns education with contemporary professional realities and strengthens students' capacity to demonstrate outcomes in design, experimentation, communication, teamwork, ethics, and lifelong learning. The proposed implementation foregrounds authentic tasks, standards-aware virtual experimentation, and assessment rubrics that reward both technical excellence and professional digital conduct. When supported by faculty development and coherent program policy, this approach yields more transparent processes, higher-quality artifacts, and more equitable participation. Future work should examine cross-disciplinary transfer, optimize scaffolding for novices, and develop validated instruments that measure the interplay between self-regulation, collaboration quality, and technical

achievement within platform-mediated learning.

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