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Enhancing Engineering Education through Digital Portfolios: Integrating Reflection, Communication, and Professional Identity Development

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Abstract

This study examines the integration of digital portfolios in first-year engineering education as a tool to foster reflection, communication confidence, and professional identity development. Recognizing that early engineering curricula often emphasize technical problem-solving over metacognitive and communicative competencies, this intervention used technology-enabled reflection and self-authorship to bridge this gap. Grounded in Schön's reflective practice theory and constructivist learning frameworks, the initiative was designed to support professional agency among novice engineers through a human-centered, technology-integrated learning environment.

A mixed-methods evaluation framework combined quantitative pre/post survey data with qualitative open-ended responses to assess outcomes aligned with ABET student outcomes in communication (SO3), lifelong learning (SO7), and design integration (SO2). Results demonstrated small-to-moderate gains in communication, design self-efficacy, and reflective practice, with effect sizes ranging from 0.36 to 0.40. Post-only indicators revealed that 75% of students perceived increased awareness of classroom-professional connections, and approximately 67% felt the portfolio helped them express their engineering identity and connect to the engineering community. These findings support digital portfolios as an effective, scalable strategy for embedding reflection and communication within early engineering curricula, strengthening students' capacity to integrate knowledge across projects and preparing them for technology-enabled professional environments.

Keywords: *Digital portfolios, Engineering education, Reflective practice, Professional identity development, First-year engineering, ABET outcomes, Assessment*

1. Introduction

First-year engineering education serves a critical role in helping students develop systems thinking, effective communication, and human-centered problem-solving; core competencies for engineering practice, particularly in Industrial Engineering (IE). Introductory engineering courses typically emphasize hands-on design and technical exposure; however, these experiences are frequently presented as isolated activities lacking opportunities for synthesis, reflection, or professional articulation. Consequently, students often complete early projects without understanding how their work connects to engineering systems, stakeholder needs, or professional practice.

Industrial Engineering particularly emphasizes the integration of technical work with reflection, communication, and data-driven decision-making. Professional IE work requires students to document processes, justify design decisions, communicate with diverse stakeholders, and reflect on system performance to drive continuous improvement. Yet these competencies frequently remain underdeveloped in the first year, where assessment structures privilege problem-solving accuracy over metacognitive growth and professional communication. Additionally, as engineering practice becomes increasingly shaped by digital tools, automation, and data analytics, students must learn not only to design systems but to communicate insights, document decisions, and reflect on outcomes in digital environments, mirroring professional workflows such as process documentation, continuous improvement reporting, and systems evaluation.

Digital engineering portfolios offer a promising response to these interconnected challenges. By requiring students to curate artifacts, reflect on learning experiences, and present their work through professional digital platforms, portfolios function as human-centered learning systems that support reflection, communication, and identity development. When implemented early in the curriculum, portfolios help students recognize engineering as an integrated system of activities rather than disconnected tasks, while portfolio artifacts simultaneously provide rich evidence for instructional decision-making and program-level continuous improvement, an area of particular relevance to IE education and ABET assessment mandates.

1.1 Research Questions and Objectives

This study examines the design, implementation, and assessment of a digital engineering portfolio assignment embedded within a first-year Introduction to Engineering course. The intervention was intentionally structured as a semester-long, scaffolded learning experience aligned with reflective practice and constructivist learning principles, leveraging accessible digital technology to create an authentic learning environment.

To evaluate the impact of this intervention, the study addresses the following research questions:

1. How does participation in a digital portfolio assignment influence first-year engineering students' reflection, communication confidence, and design self-efficacy?

2. To what extent do students perceive the digital portfolio as supporting professional identity formation and connection to engineering practice?

3. How can student feedback and learning data inform continuous improvement of portfolio-based instruction in first-year engineering courses?

This paper demonstrates how a first-year digital engineering portfolio can function as a human-centered, technology-enabled learning system that strengthens reflection, communication, and early professional identity while generating actionable data for continuous instructional improvement. The work aligns directly with Industrial Engineering education priorities by demonstrating a scalable, assessment-informed approach that integrates professional skill development with systems thinking in introductory engineering curricula and with the ASEE Industrial Engineering Division's emphasis on integrating technology, data, and human factors in engineering education.

2. Literature Review

2.1 Digital Portfolios as Alternative and Authentic Assessment

Digital portfolios (ePortfolios) have been widely examined as alternatives to traditional assessment approaches, particularly for capturing learning processes, artifacts, and longitudinal student development. Unlike time-bounded examinations, portfolios enable students to document progress, reflect on learning, and demonstrate competencies across multiple formats and contexts [1], [2]. In engineering education, this aligns with calls for more authentic, performance-based assessment practices that better reflect professional practice [3], [4].

Within engineering curricula, ePortfolios have been shown to support experiential and problem-based learning by enabling students to integrate project artifacts, design documentation, and reflective narratives [5], [6]. Studies further indicate that portfolios can function as assessment systems that foreground learning processes rather than isolated outcomes, offering richer evidence for both formative feedback and summative evaluation [7], [8].

2.2 Reflection, Experiential Learning, and Professional Identity

The pedagogical value of portfolios is strongly grounded in theories of experiential learning and reflective practice. Kolb's experiential learning cycle positions reflection as a critical mechanism through which experience is transformed into learning [9], while Schön's reflective practitioner framework emphasizes reflection-in-action and reflection-on-action as hallmarks of professional competence [10]. Digital portfolios operationalize these theories by providing structured spaces for students to connect experience, theory, and professional meaning [1].

In engineering education specifically, reflection has been linked to the development of professional identity and self-regulated learning [11], [12]. Early exposure to reflective practices, particularly in first-year courses, has been shown to support students' understanding of what it means to "become" an engineer, beyond technical problem-solving alone [13], [14]. Digital Portfolios thus serve as mechanisms for identity articulation, allowing students to narrate their growth, values, and emerging professional competencies over time [15].

2.3 Professional Skills, Communication, and 21st-Century Competencies

Engineering education literature consistently highlights the importance of professional skills such as communication, collaboration, critical thinking, and creativity, often framed as 21st-century competencies or ABET professional outcomes [16], [17]. Recent syntheses emphasize that these skills are best developed through integrative, reflective, and authentic learning experiences rather than isolated instruction [18], [19].

Digital portfolios (ePortfolios) have been shown to support these competencies by requiring students to curate artifacts, articulate learning narratives, and communicate technical and non-technical ideas to multiple audiences [20], [21]. In this way, portfolios function not only as assessment tools but also as communication systems that mirror professional engineering documentation and reporting practices [15].

2.4 Portfolios, Systems Thinking, and Continuous Improvement

From an Industrial Engineering perspective, digital portfolios can be conceptualized as learning systems that integrate inputs (learning activities), processes (reflection and synthesis), and outputs (artifacts and evidence). Prior work suggests that when intentionally designed, ePortfolios can generate actionable data to inform instructional decisions, curriculum refinement, and program-level continuous improvement [7], [4].

However, much of the existing literature focuses on portfolios in upper-division or capstone contexts, or frames them primarily as accreditation artifacts rather than as human-centered instructional systems embedded early in the curriculum [3], [8]. There remains limited empirical evidence examining how first-year digital portfolio implementations function simultaneously as student learning interventions and as data-informed mechanisms aligned with continuous improvement principles central to Industrial Engineering education [22], [23].

2.5 Research Gap and Contribution

Despite growing evidence supporting ePortfolios for reflection, assessment, and professional skill development, the literature reveals a gap in evidence-based, first-year implementations that position digital portfolios as integrated, human-centered learning systems producing actionable data for instructional improvement, rather than as isolated assessment artifacts [3], [4]. This study addresses this gap by evaluating a structured digital portfolio intervention implemented in a first-year engineering course, examining changes in student perceptions and competencies associated with portfolio use, while demonstrating how portfolio-generated data support continuous improvement aligned with Industrial Engineering education priorities.

3. Course Context and Intervention Design

3.1 Course Context

The study was conducted in a first-year Introduction to Engineering course at a small, teaching-focused institution with an emerging engineering program. The incoming engineering cohort is relatively small (approximately 15–20 students per year), and students are not formally separated into disciplines during the first year. Instead, the program follows a general engineering model in which students are introduced to multiple engineering domains before selecting or refining their areas of interest.

The course in which this study was conducted enrolled 12 students, representing the full cohort for that section. Thus, the 12 students who completed the pre- and post-surveys reflect the entire class population, and the 10 matched responses represent the subset of students with complete paired data.

Students entered the course with varying levels of prior experience in engineering design, communication, and digital tools. Course activities included hands-on design projects, teamwork, and exposure to engineering concepts; however, prior to this intervention, these experiences were primarily assessed through traditional deliverables such as reports and presentations, offering limited opportunities for synthesis, reflection, or professional articulation.

From an instructional perspective, the small class size enabled iterative feedback on portfolio development, though scaling this approach to larger cohorts would require additional instructional supports such as structured rubrics, peer review systems, or technology-assisted feedback mechanisms.

3.2 Digital Portfolio Intervention Structure

The Digital Engineering Portfolio Website was implemented as a semester-long, scaffolded assignment designed to address this instructional gap. Students created individual, web-based portfolios using Wix, an accessible platform requiring no programming experience, allowing students to focus on content, reflection, and professional presentation rather than technical implementation.

Each portfolio functioned as a living document that evolved throughout the semester. Required components included:

- **Home Page:** An introduction articulating the student's engineering interests, motivations, and emerging professional goals
- **Project Pages:** Documentation of major design projects, including problem descriptions, design approaches, constraints, outcomes, and lessons learned
- **Reflection Blog:** Periodic reflective entries connecting course activities to learning growth, design thinking, and professional practice
- **Contextual Learning Section:** Reflections on site visits, guest speakers, or field experiences
- **Professional Contact Page:** A page simulating industry-facing communication and professional presence

These components were intentionally designed to encourage students to view engineering work as a system of interconnected activities rather than isolated assignments, mirroring professional IE documentation practices.

3.3 Scaffolding and Assessment

To support student success, the portfolio assignment was scaffolded through structured checkpoints distributed across the semester. At each checkpoint, students submitted partial portfolio components and received formative feedback from both peers and the instructor. Reflection prompts guided students in articulating not only what they did but why design decisions were made and how their understanding evolved, key elements of Schön's reflective practice theory [10].

Peer feedback sessions strengthened communication and feedback literacy, with students reviewing each other's drafts using guiding questions focused on clarity, organization, and professional tone. Instructor feedback emphasized coherence, reflective depth, and alignment between artifacts and written explanations.

The portfolio assignment culminated in a portfolio showcase where students presented their websites to peers and faculty, reinforcing professional communication expectations and providing authentic audience engagement. Beyond supporting student learning, the portfolio artifacts generated rich evidence for instructional reflection and program assessment, functioning as both a learning tool and a data-informed mechanism for evaluating student development in communication, reflection, and professional identity.

4. Methods

4.1 Study Context, Participants, and ABET Alignment

This mixed-methods study was conducted in a first-year Introduction to Engineering course at a small teaching-focused institution. The 16-week intervention involved twelve students who completed pre-surveys and twelve who completed post-surveys; ten students provided matched pre/post responses suitable for paired analysis. Participation in surveys was voluntary and did not affect course grades; all students completed the portfolio assignment as part of regular coursework.

The digital portfolio assignment and associated assessment instruments were intentionally aligned with ABET student outcomes relevant to first-year engineering education [22]:

- **SO3 (Communication):** Ability to communicate effectively with a range of audiences through written, visual, and oral formats
- **SO7 (Lifelong Learning):** Ability to acquire and apply new knowledge as needed, using appropriate learning strategies, supported through reflective practice
- **SO2 (Engineering Design):** Ability to apply engineering design to produce solutions that meet specified needs, including consideration of constraints and broader impacts
- **SO5 (Teamwork):** Ability to function effectively on a team, including collaboration, communication, and shared responsibility

Portfolio artifacts and survey instruments were designed to capture elements of these outcomes, particularly emphasizing communication, reflection, and design articulation. Portfolio outputs also served as formative evidence for program-level assessment and continuous improvement efforts.

4.2 Data Collection Instruments

A five-point Likert scale survey (1 = Strongly Disagree to 5 = Strongly Agree) measured six conceptually aligned constructs:

- **Communication and Presentation** (7 items): comfort with technical writing, visual design, and explaining work to others

- **Design Self-Efficacy** (3 items): confidence in design problem-solving and systems thinking
- **Reflection and Metacognition** (7 items): ability to reflect on learning and connect coursework to professional practice
- **Digital Fluency and Portfolio Skills** (2 items): comfort with web-based tools and digital documentation
- **Teamwork and Feedback** (3 items): collaboration skills and receptiveness to feedback
- **Engineering Identity and Professional Purpose** (5 items): sense of belonging in engineering and connection to professional practice

The post-survey included portfolio-specific impact indicators designed to capture students' direct attribution of learning to the portfolio experience. Qualitative data were collected through open-ended survey responses asking students to reflect on learning, challenges, and perceived value of the digital portfolio.

4.3 Procedure and Data Analysis

The pre-survey was administered early in the semester, prior to substantial portfolio engagement, establishing baseline measures of reflection habits, communication confidence, and engineering identity. Students then developed portfolios incrementally throughout the semester with instructional guidance, reflection prompts, and peer review opportunities. The post-survey was administered in the final weeks after portfolio completion and presentation.

Quantitative analysis focused on paired pre/post comparisons ($n = 10$). Mean scores were calculated for each construct and paired-sample effect sizes (Cohen's dz) estimated the magnitude of observed changes. Consistent with ASEE recommendations for small-N classroom studies, effect sizes and descriptive trends were used to interpret practical significance [23]. Post-only portfolio impact indicators were analyzed descriptively using means and percentage of students selecting agree or strongly agree (ratings of 4–5). Open-ended responses were reviewed using inductive thematic analysis to identify recurring patterns related to reflection, communication, identity formation, and feedback.

5. Results

5.1 Quantitative Outcomes: Pre/Post Construct Changes

Table 1 presents pre- and post-intervention means for each construct with paired-sample effect sizes. Most constructs showed increases from baseline, with communication and reflective practice showing the largest gains.

The largest gains occurred in communication and presentation skills ($dz = 0.36$) and design self-efficacy ($dz = 0.40$), followed by reflection and metacognition ($dz = 0.39$). These effect sizes are practically meaningful for first-year interventions. Teamwork scores showed no change, likely reflecting already-high baseline engagement in this course's collaborative design work.

Table 1: Pre- and post-intervention means for each construct

Construct	**Items**	**Pre Mean**	**Post Mean**	**Δ**	**Cohen's *dz***
Communication & Presentation	7	3.54	3.69	+0.15	0.36
Design Self-Efficacy	3	3.65	3.77	+0.12	0.40
Reflection & Metacognition	7	3.43	3.54	+0.11	0.39
Digital Fluency / Portfolio Skills	2	3.93	4.00	+0.08	0.12
Teamwork & Feedback	3	4.20	4.20	+0.00	~0.00
Engineering Identity & Purpose	5	3.84	3.82	−0.02	−0.05

Note: Effect sizes for communication, reflection, and design self-efficacy fall within the small-to-moderate range (0.36–0.40), consistent with short-duration, first-semester interventions. Teamwork remained high across administrations, suggesting a ceiling effect.

To contextualize these quantitative findings, open-ended responses indicate that students experienced meaningful shifts in how they understood and reflected on their learning. While early responses reflected limited clarity about portfolio purpose (e.g., *"an overview of my work and experience"*), post-survey responses emphasized increased awareness of learning:

"It helped me think about [engineering] in a more critical way."
"Writing about my journey helped me understand what I've learned."

These reflections support the observed gains in metacognition and suggest that even modest numerical changes correspond to meaningful perceived learning.

5.2 Portfolio-Specific Impact Indicators

To capture students' direct attribution of learning to the portfolio experience, post-only survey items focused on perceived growth, professional connection, and identity expression. Table 2 presents these results.

These post-only indicators reveal that students perceived the portfolio as meaningfully contributing to professional development. Notably, 75% of students reported increased awareness of classroom-professional connections, and approximately 67% felt the portfolio helped them express their engineering identity and connect to the engineering community. This finding contextualizes the modest changes in the general engineering identity scale (Table 1), suggesting that portfolio-specific measures may be more sensitive to early identity development than generic measures.

Student responses further highlight improvements in communication and articulation of engineering work:

"It allowed me to express myself in my own way."
"I would work on articulating my projects better."

Portfolio components such as project pages and reflection blogs were frequently identified as central to this development, reinforcing the quantitative gains observed in communication-related constructs.

Table 2: Post-Implementation Survey results on portfolio experience

Indicator	Mean	% Agree (4–5)
Portfolio helped identify strengths and growth	3.58	75%
Increased awareness of classroom–professional connections	3.75	75%
Helped express "who I am as an engineer"	3.67	66.7%
Increased connection to the engineering community	3.75	66.7%
Increased confidence pursuing engineering career	3.50	58.3%
Used feedback to revise portfolio	3.42	58.3%
Reflections improved understanding of design process	3.25	50.0%

5.3 Student Perceptions of Professional Development and Challenges

Qualitative responses also provide insight into students' evolving professional identity and perceptions of the portfolio's long-term value. Many students described a growing sense of ownership and professional direction:

"My story and path I want to pursue represents my growth."

Students consistently recognized the portfolio as a career-relevant artifact:

"I'll include a link on my resume."
"Show my work in interviews."

However, responses also indicate variability in impact. A small number of students reported limited change in their perception of engineering (e.g., *"It didn't change the way*

I think about engineering"), suggesting that identity development may occur unevenly across individuals and may require longer-term reinforcement.

Students also identified challenges related to teamwork and communication:

"I overcame conflicting ideas with other people."
"Public speaking."

These responses highlight the role of the portfolio and associated activities in supporting broader professional skills, including collaboration and communication, which are central to ABET outcomes and Industrial Engineering practice

6. Discussion

6.1 Addressing Research Questions

The results address each research question directly.

Research Question 1: Influence on reflection, communication confidence, and design self-efficacy. Quantitative and qualitative data confirm that participation in the portfolio assignment positively influenced all three constructs. Communication and presentation skills showed the strongest gains (*dz* = 0.36), reflecting the portfolio's emphasis on artifact curation and professional storytelling, increasingly valuable competencies in data-driven and interdisciplinary engineering environments. Improvements in reflection and metacognition (*dz* = 0.39) were consistent, particularly in students' ability to connect coursework to real-world engineering practice. Design self-efficacy gains (*dz* = 0.40) suggest that experiencing integrated design work across the semester strengthened students' confidence in problem-solving. These findings support the assignment's grounding in reflective practice and experiential learning theories [9], [10].

Research Question 2: Professional identity formation and connection to engineering practice. Engineering identity scores in paired analyses remained stable, likely reflecting high baseline self-identification among first-year engineering students. However, post-only indicators reveal meaningful differences: 75% of students reported increased awareness of how classroom learning connects to professional practice, and approximately 67% perceived the portfolio as helping them express their engineering identity and connect to the engineering community. This distinction suggests that portfolio-specific identity measures more sensitively capture early professional identity development than generic identity scales. The qualitative findings that students reported pride in "showing what they can do as an engineer" aligns with contemporary research on identity development through authentic assessment and public presentation [11], [15].

Research Question 3: Using student feedback and learning data for continuous improvement. Portfolio artifacts provided actionable evidence for instructional decision-making. Student feedback on the portfolio process highlighted the need for more structured feedback mechanisms, particularly exemplars, targeted rubrics, and required revision cycles. While 58.3% of students reported using feedback to revise their portfolios, qualitative responses indicated uncertainty about how to implement feedback effectively. This finding suggests that future iterations should emphasize formative feedback scaffolding, a refinement directly informed by student data consistent with continuous improvement priorities in Industrial Engineering education.

6.2 Implications for Engineering Education

The findings demonstrate that digital portfolios serve as a practical, scalable tool for strengthening first-year engineering education. While broadly applicable across engineering disciplines, the intervention aligns particularly well with Industrial Engineering principles, including systems thinking, process documentation, and continuous improvement. The low-cost, web-based platform (Wix) requires no specialized resources, making the intervention accessible to diverse institutional contexts.

From an Industrial Engineering perspective, the portfolio functions as a human-centered learning system, integrating inputs (learning activities), processes (reflection and synthesis), and outputs (artifacts and communication). Students engage in practices analogous to professional IE workflows, including documenting processes, communicating system performance, and reflecting on outcomes to improve future work.

Additionally, portfolio artifacts provide structured data that can inform data-driven instructional decisions, supporting continuous improvement at both the course and program levels. This dual function, both as a learning tool and an assessment system, aligns with Industrial Engineering's emphasis on optimizing systems through feedback, measurement, and iterative refinement that are central to engineering program accreditation and accountability [22].

6.3 AI Use, Authenticity, and Feedback Integrity

Given the increasing use of generative AI tools in educational settings, considerations of authenticity and academic integrity are important in portfolio-based learning environments. While AI tools may support drafting, idea generation, or feedback, the portfolio assignment in this study was structured to emphasize authentic student reflection and personal articulation of learning.

Several instructional strategies supported originality:

- Reflection prompts required personalized, experience-based responses tied directly to specific projects
- Portfolio checkpoints emphasized process documentation, including drafts and revisions
- Instructor and peer feedback focused on alignment between artifacts and written reflection, making externally generated content more detectable
- Students were encouraged to view the portfolio as a professional representation of their own work, increasing ownership and accountability

Future implementations may incorporate AI-supported feedback systems; however, these should be carefully designed to augment, not replace student thinking, and to preserve the reflective and human-centered nature of the learning process

6.4 Limitations and Caveats

Several limitations should be acknowledged. The sample size was small (n = 10 paired), limiting statistical power and generalizability beyond this institutional context. The study employed a single-group pre/post design without a control or comparison group, which limits causal inference regarding the effectiveness of the intervention relative to alternative instructional approaches.

The study also relied primarily on self-reported survey data, which may be subject to response bias and end-of-semester fatigue. Engineering identity measures may exhibit ceiling effects in first-year populations who already identify with engineering. Additionally, the intervention was implemented in a single course at one institution, and results may not directly generalize to larger programs or different institutional contexts.

7. Conclusions and Future Directions

This evidence-based practice study demonstrates that digital engineering portfolios can serve as an effective and scalable strategy for enhancing communication, reflection, and professional identity development in first-year engineering education. Quantitative results showing small-to-moderate gains in key constructs, combined with post-survey indicators and qualitative feedback confirming students' attribution of professional growth to the portfolio experience, provide converging evidence of pedagogical value.

From an Industrial Engineering education standpoint, the portfolio provides a human-centered, technology-enabled approach that supports ABET-aligned outcomes in communication (SO3), lifelong learning (SO7), and design integration (SO5). Students demonstrated enhanced capacity to integrate knowledge across projects, express design reasoning in visual and verbal forms, and recognize connections between classroom learning and professional practice. The portfolio artifacts also offer valuable evidence for program assessment and continuous improvement, an ongoing institutional priority.

Overall, this intervention supports a shift in first-year engineering from isolated technical tasks toward integrated, reflective, professionally oriented learning experiences that equip students to communicate effectively and think systemically in increasingly data-rich and automated engineering environments.

7.1 Recommendations for Practice

Based on findings, the following enhancements are recommended for future implementations:

1. **Strengthen feedback scaffolding** through exemplars, targeted rubrics, and required revision cycles to improve students' capacity to apply feedback

2. **Integrate longitudinal tracking** to assess how portfolio practices influence subsequent engineering coursework and professional engagement
3. **Expand portfolio-specific assessment measures** that capture early-stage professional identity development more sensitively than generic identity scales
4. **Develop AI-enabled feedback mechanisms** and data dashboards to support instructor efficiency and provide real-time outcome monitoring for program improvement

7.2 Future Research Directions

Future work will expand this study across multiple cohorts and institutions to improve generalizability and examine consistency of outcomes. Comparative studies incorporating control groups or alternative instructional approaches will help establish causal relationships between portfolio use and student learning outcomes.

Longitudinal research will track how portfolio practices influence student development beyond the first year, including communication, reflection, and professional identity formation. Additional work will also explore AI-supported feedback systems and learning analytics dashboards to enhance scalability, while maintaining a focus on authenticity and student-centered reflection. Integration across engineering program sequences and collaboration with ASEE IED initiatives will strengthen the evidence base for portfolio-based pedagogy in engineering education.

References

[1] J. Zubizarreta, *The Learning Portfolio: Reflective Practice for Improving Student Learning*. New York: John Wiley & Sons, 2009.

[2] D. Cambridge, "ePortfolios for lifelong learning and assessment," *J. Res. Technol. Educ.*, vol. 42, no. 4, pp. 359–376, Dec. 2010.

[3] E. Walland and S. Shaw, "E-portfolios in teaching, learning and assessment: Tensions in theory and praxis," *Technol. Pedagogy Educ.*, vol. 31, no. 3, pp. 363–379, 2022.

[4] J. H. Nieminen, M. Bearman, and R. Ajjawi, "Designing the digital in authentic assessment: Is it fit for purpose?" *Assessment Eval. Higher Educ.*, vol. 48, no. 4, pp. 529–543, 2023.

[5] U. Jartarghar, P. Hegade, and A. Shettar, "Portfolio assessments for problem-based learning courses," *J. Eng. Educ. Transform.*, pp. 252–259, 2025.

[6] G. Tembrevilla, A. Phillion, and M. Zeadin, "Experiential learning in engineering education: A systematic literature review," *J. Eng. Educ.*, vol. 113, no. 1, pp. 195–218, 2024.

[7] M. Peet, S. Lonn, P. Gurin, K. K. Boyer, N. Ivancheva, E. Brown, and A. J. Maclachlan, "Fostering integrative knowledge through ePortfolios," *New Dir. Teach. Learn.*, vol. 126, pp. 31–42, 2011.

[8] H. Barrett, "Balancing the two faces of ePortfolios," in *ePortfolios: Proven Practices for Colleges and Universities*, S. Hirtz, Ed. San Francisco: Jossey-Bass, 2011.

[9] D. A. Kolb, *Experiential Learning: Experience as the Source of Learning and Development*. Englewood Cliffs, NJ: Prentice Hall, 1984.

[10] D. A. Schön, *The Reflective Practitioner: How Professionals Think in Action*. New York: Basic Books, 2017.

[11] A. Godwin, G. Potvin, and Z. Hazari, "Pushing and pulling Sara: A case study of social class, science identity, and science aspirations," *J. Res. Sci. Teach.*, vol. 53, no. 4, pp. 527–548, 2017.

[12] R. Stevens, K. O'Connor, L. Garrison, A. Jocuns, and D. M. Amos, "Becoming an engineer: Toward a three dimensional view of engineering learning," *J. Eng. Educ.*, vol. 97, no. 3, pp. 355–368, 2008.

[13] K. Meyers, M. Ohland, A. L. Pawley, S. E. Silliman, and K. A. Smith, "Factors relating to engineering identity," *Glob. J. Eng. Educ.*, vol. 14, no. 1, pp. 119–131, 2012.

[14] S. D. Sheppard, K. Macatangay, A. Colby, and W. M. Sullivan, *Educating Engineers: Designing for the Future of the Field*. San Francisco: Jossey-Bass, 2009.

[15] J. D. Ford and D. Crawford, "Integrating professional preparedness ePortfolios within an undergraduate engineering curriculum," *IEEE Trans. Prof. Commun.*, vol. 67, no. 2, pp. 246–259, 2024.

[16] L. J. Shuman, M. Besterfield-Sacre, and J. McGourty, "The ABET 'professional skills'—Can they be taught? Can they be assessed?" *J. Eng. Educ.*, vol. 94, no. 1, pp. 41–55, 2005.

[17] ABET, *2023–2024 Criteria for Accrediting Engineering Programs*. Baltimore: ABET, 2023.

[18] B. Thornhill-Miller, A. Camarda, M. Mercier, J. M. Burkhardt, T. Morisseau, S. Bourgeois-Bougrine, and T. Lubart, "Creativity, critical thinking, communication, and collaboration: Assessment, certification, and promotion of 21st century skills for the future of work and education," *J. Intell.*, vol. 11, no. 3, p. 54, 2023.

[19] S. P. Patil and A. C. Adamuthe, "Exploring holistic factors shaping undergraduate engineering student development," *J. Eng. Educ. Transform.*, pp. 25–38, 2025.

[20] I. Kakepoto, A. Laghari, and T. Laghari, "Communication barriers among undergraduate engineering students: Assignment project," *Univ. Chitral J. Linguistics Lit.*, vol. 6, no. 1, pp. 89–102, 2022.

[21] P. Polly, D. M. Salopek, J. Mo, G. Mount, P. Neal, C. Ryan, and N. Yoshioka, "An ePortfolio recommendations roadmap supported by a UNSW Sydney education focused (EF) Academic Fellowship program: Reflective practice and feedback literacy within ePortfolios matters," *J. Univ. Teach. Learn. Pract.*, vol. 22, no. 3, pp. 1–16, 2025.

[22] ABET, *2023–2024 Criteria for Accrediting Engineering Programs*. Baltimore: ABET, 2023.

[23] T. Boye, J. Lindeck, T. Machet, G. Miao, S. Daniel, R. Goldsmith, and E. Cheng, "Collaborative teaching approaches in Engineering and IT," in *Proc. 35th Annu. Conf. Australasian Assoc. Eng. Educ. (AAEE 2024)*, Christchurch, New Zealand, Dec. 2024, pp. 2–10.

APPENDICES

Appendix I

Pre-Survey: First-Year Engineering & Digital Portfolio

This pre-survey gathers baseline information on your design thinking, digital literacy, communication, and professional identity before the start of the course.

Section A: Background Information

Intended Engineering Discipline or Major: ________________________

Prior experience with online portfolios or website platforms (e.g., Wix, WordPress):
☐ None ☐ Limited ☐ Moderate ☐ Extensive

Prior engineering or design experience: ☐ None ☐ Minimal ☐ Moderate ☐ Extensive

Comfort level with digital tools and software (1 = Not comfortable → 5 = Very comfortable):
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Describe briefly what you think an engineering portfolio is:

____

____

Sections B: Likert Scale Items (1 = Strongly Disagree → 5 = Strongly Agree)

#	Statement	1	2	3	4
1	I regularly reflect on how I learn in engineering courses.	☐	☐	☐	☐
2	I can identify my strengths and weaknesses as a learner.	☐	☐	☐	☐
3	I see connections between classroom topics and real-world engineering practice.	☐	☐	☐	☐
4	I know how to articulate how my design process works.	☐	☐	☐	☐
5	I use reflection to improve my technical performance.	☐	☐	☐	☐
6	I document my learning process effectively through portfolios or notebooks.	☐	☐	☐	☐
7	I am confident writing about technical topics for a general audience.	☐	☐	☐	☐
8	I can visually present engineering work in a clear and professional way.	☐	☐	☐	☐
9	I feel prepared to discuss my technical work with peers or faculty.	☐	☐	☐	☐
10	My current writing and presentation skills meet professional standards.	☐	☐	☐	☐
11	Peer feedback helps me improve how I communicate my work.	☐	☐	☐	☐
12	I can explain how engineering improves society and everyday life.	☐	☐	☐	☐
13	I see myself as an emerging engineer.	☐	☐	☐	☐
14	I understand how different engineering disciplines connect (civil, mechanical, electrical, environmental).	☐	☐	☐	☐
15	I am motivated to pursue a future in engineering.	☐	☐	☐	☐
16	I can apply the steps of the engineering design process to new problems.	☐	☐	☐	☐

17	I feel confident creating and testing design prototypes.	☐	☐	☐	☐
18	I can identify the constraints and criteria for successful design solutions.	☐	☐	☐	☐
19	I am comfortable making design decisions in a team setting.	☐	☐	☐	☐
20	I can provide and receive constructive feedback from peers.	☐	☐	☐	☐
21	I feel respected and valued in my project team.	☐	☐	☐	☐
22	I am improving my technical communication skills (written, visual, oral).	☐	☐	☐	☐
23	I understand how engineering connects to ethical and societal issues.	☐	☐	☐	☐
24	I am more confident using digital tools and engineering software.	☐	☐	☐	☐
25	I can manage and present my engineering work in an online portfolio format.	☐	☐	☐	☐
26	I reflect on how my projects demonstrate growth in curiosity, creativity, and connection (3 Cs).	☐	☐	☐	☐

Section C: Open-Ended Reflection

What do you hope to gain from developing your digital or engineering portfolio this semester?

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Describe any concerns you have about public or digital presentation of your work.

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What personal or professional skills do you hope to strengthen in this course?

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In what ways do you think hands-on or project-based learning will influence your development as an engineer?

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Appendix II

Post-Survey: First-Year Engineering & Digital Portfolio

This post-survey evaluates your experience and learning outcomes from the first-year engineering course, with emphasis on digital portfolio development, teamwork, reflection, and professional identity formation.

Section A: Portfolio Experience

Average hours per week spent developing your portfolio: ☐ <1 ☐ 1–3 ☐ 3–5 ☐ 5+

Which components did you complete in your portfolio? ☐ Home Page ☐ Project Pages
☐ Reflection Blog ☐ Field Experience ☐ Contact Page_

Prior experience with online portfolios or website platforms (e.g., Wix, WordPress):
☐ None ☐ Limited ☐ Moderate ☐ Extensive

Number of peer feedback sessions participated in: ☐ None ☐ 1–2 ☐ 3–4 ☐ 5 or more:

Comfort level with digital tools and software (1 = Not comfortable → 5 = Very comfortable):
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Describe briefly what you think an engineering portfolio is:

Sections B: Likert Scale Items (1 = Strongly Disagree → 5 = Strongly Agree)

#	Statement	1	2	3	4	5
1	I regularly reflect on how I learn in engineering courses.	☐	☐	☐	☐	☐
2	I can identify my strengths and weaknesses as a learner.	☐	☐	☐	☐	☐
3	I see connections between classroom topics and real-world engineering practice.	☐	☐	☐	☐	☐
4	I know how to articulate how my design process works.	☐	☐	☐	☐	☐
5	I use reflection to improve my technical performance.	☐	☐	☐	☐	☐
6	I document my learning process effectively through portfolios or notebooks.	☐	☐	☐	☐	☐
7	I am confident writing about technical topics for a general audience.	☐	☐	☐	☐	☐
8	I can visually present engineering work in a clear and professional way.	☐	☐	☐	☐	☐
9	I feel prepared to discuss my technical work with peers or faculty.	☐	☐	☐	☐	☐
10	My current writing and presentation skills meet professional standards.	☐	☐	☐	☐	☐
11	Peer feedback helps me improve how I communicate my work.	☐	☐	☐	☐	☐
12	I can explain how engineering improves society and everyday life.	☐	☐	☐	☐	☐
13	I see myself as an emerging engineer.	☐	☐	☐	☐	☐
14	I understand how different engineering disciplines connect (civil, mechanical, electrical, environmental).	☐	☐	☐	☐	☐

15	I am motivated to pursue a future in engineering.	☐	☐	☐	☐	☐
16	I can apply the steps of the engineering design process to new problems.	☐	☐	☐	☐	☐
17	I feel confident creating and testing design prototypes.	☐	☐	☐	☐	☐
18	I can identify the constraints and criteria for successful design solutions.	☐	☐	☐	☐	☐
19	I am comfortable making design decisions in a team setting.	☐	☐	☐	☐	☐
20	I can provide and receive constructive feedback from peers.	☐	☐	☐	☐	☐
21	I feel respected and valued in my project team.	☐	☐	☐	☐	☐
22	I am improving my technical communication skills (written, visual, oral).	☐	☐	☐	☐	☐
23	I understand how engineering connects to ethical and societal issues.	☐	☐	☐	☐	☐
24	I am more confident using digital tools and engineering software.	☐	☐	☐	☐	☐
25	I can manage and present my engineering work in an online portfolio format.	☐	☐	☐	☐	☐
26	I reflect on how my projects demonstrate growth in curiosity, creativity, and connection (3 Cs).	☐	☐	☐	☐	☐
27	The portfolio process helped me identify my strengths and growth as a learner	☐	☐	☐	☐	☐
28	Writing reflections improved my understanding of the design process.	☐	☐	☐	☐	☐
29	I am more aware of how classroom learning connects to professional content	☐	☐	☐	☐	☐
30	I regularly used feedback from peers/instructors to revise my portfolio.	☐	☐	☐	☐	☐
31	Developing the portfolio improved my teamwork and feedback literacy.	☐	☐	☐	☐	☐
32	The portfolio helped me express who I am as an engineer.	☐	☐	☐	☐	☐
33	I feel more connected to the engineering community.	☐	☐	☐	☐	☐
34	The portfolio made me more confident in pursuing my career path.	☐	☐	☐	☐	☐

Section C: Open-Ended Reflection

How did the digital portfolio project change the way you think about engineering?

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Which part of your portfolio most effectively represents your growth as an engineer?

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What would you improve if you were to continue building your portfolio?

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How do you plan to use your portfolio for internships, courses, or professional networking?

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Reflecting on the semester, what part of your learning or design process improved the most?

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Describe one challenge you overcame while working on your portfolio or team projects.

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