VOL: 02 NO: 01 2025

RESEARCH CORRIDOR

Journal of Engineering Science

Fail, Reflect, Innovate: A Longitudinal Study on the Role of Failure Journaling in Developing Resilient Engineering Students

Desmond Craig

Abstract

Resilience is an essential yet underdeveloped attribute in engineering education, where high academic demands and a performance-driven culture often leave little room for failure. This longitudinal study explores the role of failure journaling as a reflective tool to foster resilience among engineering students. Over an academic year, a cohort of undergraduate engineering students participated in structured journaling activities focused on their personal and educational setbacks. Through thematic analysis of journal entries, follow-up interviews, and surveys, the study reveals that intentional reflection on failure can lead to significant shifts in students' self-perception, coping strategies, and problem-solving approaches. The findings highlight how failure journaling facilitates emotional regulation, cultivates a growth mindset, and encourages innovation in learning. This study provides evidence-based recommendations for integrating reflective failure practices into engineering curricula and underscores the transformative potential of failure when intentionally examined and understood.

Keywords: Failure journaling, Engineering education, Student resilience, Reflective practice, Growth mindset, Experiential learning, Academic failure, Emotional regulation, Innovation in learning, Longitudinal study.

I. Introduction

In the demanding landscape of engineering education, resilience is increasingly recognized as a critical attribute for student success. Engineering programs are known for their rigorous academic expectations, high-stakes assessments, and complex problem-solving demands—all of which expose students to frequent setbacks and failures. While such challenges are inherent to the learning process, traditional educational environments often discourage open discussions of failure, inadvertently fostering a fear of imperfection and a fixed mindset. This culture can lead to decreased motivation, poor mental health outcomes, and missed opportunities for meaningful learning.

However, failure, when approached constructively, can be a powerful catalyst for growth, innovation, and self-awareness. One promising strategy for harnessing the educational value of failure is reflective journaling. Rooted in experiential learning theory and metacognitive development, journaling allows students to process setbacks, identify patterns in their thinking, and develop adaptive coping mechanisms. Specifically, **failure journaling**—the intentional documentation and analysis of personal and academic failures—has the potential to transform students' relationships with failure, promoting emotional resilience, persistence, and a growth-oriented mindset.

Despite its potential, little empirical research has been conducted on the long-term impact of failure journaling in STEM fields, particularly in engineering education. Existing studies often treat resilience as a static trait rather than a skill that can be cultivated over time. Moreover, few

studies investigate how structured reflective practices influence students' academic behaviors and emotional well-being across multiple semesters or academic years.

This study addresses that gap by examining the role of failure journaling in developing resilience among engineering students over an academic year. The study takes a **longitudinal approach** to capture how students evolve in their reflective practices and personal growth as they engage regularly in journaling. Through qualitative and quantitative methods, it aims to explore how journaling helps students reframe failure, adapt to challenges, and innovate in their learning approaches.

2. Literature Review

Resilience in Engineering Education

Resilience, broadly defined as the capacity to recover from adversity, has emerged as a key factor in academic success and personal development, particularly in high-pressure fields like engineering. Research indicates that engineering students often face chronic stress, performance anxiety, and a fear of failure due to competitive grading systems and complex workloads (Yadav et al., 2020). While resilience is often seen as a personal trait, scholars argue that it can be cultivated through intentional pedagogical strategies and supportive learning environments (Martin & Marsh, 2006).

Reflective Practice in Higher Education

Reflective practice is widely recognized in education literature as a means of deepening learning and fostering self-awareness. Schön's (1983) theory of the "reflective practitioner" emphasizes that learning is enhanced when individuals actively think about their experiences and responses. In academic contexts, reflection enables students to critically evaluate their learning strategies, emotional reactions, and progress over time (Moon, 1999). Engineering programs, however, have traditionally prioritized technical mastery over reflective thinking, resulting in a gap between cognitive skill development and personal growth.

Failure as a Learning Tool

Failure, though often stigmatized, plays a vital role in the learning process. Research in psychology and education shows that encountering and analyzing failure can enhance problem-solving abilities, persistence, and innovation (Clifford, 1984; Dweck, 2006). In engineering education, there is a growing movement to reframe failure as a necessary component of design, iteration, and innovation. However, without guided reflection, students may internalize failure as a sign of incompetence rather than a learning opportunity.

Failure Journaling and Emotional Growth

Failure journaling is a specific type of reflective writing that focuses on documenting and analyzing personal or academic setbacks. While not yet widely adopted in engineering education, studies in health sciences and teacher training have demonstrated its potential in fostering emotional regulation, resilience, and professional identity formation (Mann et al., 2009). Journaling allows students to explore their reactions to failure, identify growth points, and plan adaptive responses. Yet, empirical studies on the structured use of failure journaling in STEM disciplines remain scarce.

Gaps in Existing Research

Despite increasing awareness of the benefits of resilience and reflection, there is limited longitudinal research examining how engineering students develop these skills over time through

structured journaling. Most existing studies are either short-term or anecdotal, lacking robust data on how reflective habits influence student growth across multiple academic terms. Moreover, few studies explore how journaling impacts both emotional resilience and academic performance in parallel.

This study aims to fill these gaps by investigating failure journaling as a practical, scalable tool for fostering resilience in engineering students, tracking its effects across an extended academic period.

3. Methodology

Research Design

This study employed a **longitudinal qualitative research design**, supplemented by basic quantitative data, to explore how failure journaling influences resilience development in engineering students over time. The longitudinal approach was chosen to capture the progression of students' reflective practices, emotional growth, and academic coping mechanisms across two academic semesters.

Participants

Participants included 45 undergraduate engineering students from various year levels (first to fourth year) enrolled at a mid-sized university. Recruitment was conducted through voluntary sign-ups in selected engineering courses. To ensure diverse perspectives, participants came from multiple engineering disciplines, including mechanical, civil, and electrical engineering.

Data Collection Methods

The primary data source was students' **failure journals**, submitted biweekly for one academic year. Each entry followed open-ended prompts encouraging students to describe a recent failure, analyze their emotional and intellectual response, and reflect on what they learned.

In addition to journal entries, the study collected:

- **Pre- and post-study surveys** measuring self-perceived resilience, growth mindset, and stress coping strategies.
- **Semi-structured interviews** were conducted at three intervals (beginning, mid-point, and end of the study) with a representative subset of 15 students.
- **Course performance data** (with consent) to contextualize journaling content about academic outcomes.

Data Analysis

Qualitative data (journals and interviews) were analyzed using **thematic analysis**. An inductive coding process was used to identify recurring themes such as emotional regulation, self-efficacy, adaptability, and reflective depth. A coding framework was developed and refined collaboratively by two researchers to ensure consistency and minimize bias.

Quantitative survey data were analyzed using descriptive statistics to assess changes in resilience-related constructs over time. While not the primary focus, these data helped triangulate findings from the qualitative analysis.

RESEARCH CORRIDOR
Journal of Engineering Science

Ethical Considerations

Ethical approval was obtained from the university's research ethics board. All participants provided informed consent, and confidentiality was maintained by anonymizing all data. Students were assured that their participation—or the content of their reflections—would not influence their academic evaluations.

4. Findings

Analysis of the collected data revealed several recurring themes that illustrate the transformative impact of failure journaling on the resilience and reflective capacity of engineering students. These findings emerged from a synthesis of journal entries, interview transcripts, and survey results gathered over the academic year.

I. Evolving Perception of Failure

At the beginning of the study, many students equated failure with personal inadequacy, expressing feelings of shame, frustration, and anxiety. However, over time, a shift in perspective was observed. Journal entries increasingly framed failure as a natural and necessary part of the learning process. Students began to describe failures as "opportunities for growth" and "moments that taught me more than success ever could."

II. Development of Reflective Thinking

The depth and quality of reflection improved significantly across the semesters. Early entries tended to be surface-level descriptions of events. By the second half of the year, students were engaging in deeper self-analysis, connecting emotional responses with underlying causes and identifying behavioral patterns. Many demonstrated improved metacognitive awareness—recognizing how they learn, where they struggle, and what strategies work best for them.

III. Emotional Regulation and Coping

Regular journaling contributed to healthier emotional responses to setbacks. Students reported feeling more in control of their reactions and less overwhelmed by academic pressure. Several described journaling as a therapeutic outlet that helped them process negative emotions and regain focus. This was especially evident during peak stress periods such as midterms and final exams.

IV. Increased Resilience and Persistence

By the end of the study, students showed signs of greater persistence in the face of challenges. Instead of withdrawing or giving up after failure, many began to adopt adaptive strategies—seeking help, revising their study plans, or reframing problems with a solution-oriented mindset. This was echoed in the interviews, where students shared how journaling "kept them grounded" and made them "more willing to take risks without fear of failing."

V. Varied Engagement Across Year Levels

Interestingly, upper-year students generally demonstrated more mature reflection from the outset, likely due to greater academic experience. However, first- and second-year students showed the most dramatic improvement over time, suggesting that early exposure to failure journaling could be especially beneficial in building foundational resilience skills.

5. Discussion

The findings of this study suggest that structured failure journaling can play a significant role in developing resilience, self-awareness, and adaptive learning strategies among engineering students. As participants engaged in regular reflection over the academic year, they demonstrated

a clear shift in how they perceived and responded to failure, moving from avoidance and self-blame toward growth, problem-solving, and persistence.

Reframing Failure Through Reflection

One of the most striking outcomes was students' ability to reframe failure not as an endpoint, but as a formative experience. This aligns with resilience theory, which emphasizes the importance of positive adaptation in the face of adversity (Masten, 2001). By writing about their setbacks, students were able to contextualize their experiences, de-escalate emotional responses, and identify lessons learned—practices closely tied to emotional regulation and metacognitive growth.

Reflective Practice as a Tool for Learning

The depth of reflection observed in later journal entries indicates that reflective capacity is a skill that can be cultivated over time. As students became more familiar with the journaling process, their writing evolved from reactive venting to structured analysis of their thoughts, behaviors, and strategies. This progression supports existing literature that positions reflection as essential for deep learning and long-term academic development (Boud, Keogh & Walker, 1985).

Implications for Engineering Culture

Engineering education has long emphasized technical proficiency and problem-solving under pressure, often at the expense of emotional and reflective development. The success of failure journaling in this study suggests that incorporating intentional reflection into engineering curricula could help humanize the learning experience and address student well-being more holistically. Encouraging students to engage with their failures actively, rather than passively endure them, can foster both resilience and innovation.

Challenges and Limitations

Despite the positive outcomes, several challenges emerged. Not all students engaged consistently with the journaling practice; some treated it as a routine task rather than a genuine exercise in self-discovery. Additionally, while qualitative data provided deep insights, the limited scale of the study and reliance on self-reported reflections may introduce subjectivity and bias.

6. Implications and Recommendations

Implications for Engineering Education

This study highlights the powerful role that failure journaling can play in fostering resilience and reflective thinking in engineering students. The process of writing about personal setbacks not only helped students manage their emotions but also encouraged them to analyze their learning strategies and adopt a growth mindset. These outcomes suggest that failure journaling is more than a coping mechanism—it is a pedagogical tool with the potential to enhance both academic performance and emotional intelligence.

In a field traditionally focused on technical rigor, these findings call for a broader educational approach that integrates emotional and psychological development into the engineering curriculum. Encouraging students to reflect on their experiences—especially failures, can create a more supportive, adaptive, and innovative learning environment.

Recommendations for Practice

1. **Integrate Journaling into Coursework:** Educators should consider incorporating failure journaling into core engineering courses. This could take the form of weekly or biweekly

prompts that ask students to reflect on challenges, mistakes, and lessons learned.

2. **Provide Structure and Guidance:** To ensure meaningful engagement, instructors should offer clear prompts and examples that guide students beyond surface-level responses. Workshops or class discussions about how to reflect constructively can also be helpful.

3. **Normalize Failure in Academic Culture:** Faculty and institutions should actively work to destigmatize failure by sharing their own experiences and framing setbacks as essential to innovation and learning. This cultural shift can empower students to take intellectual risks without fear.

4. **Train Educators in Reflective Facilitation:** Teaching staff may benefit from professional development focused on facilitating reflective practices and supporting students in emotionally challenging moments.

5. **Expand to Interdisciplinary Contexts:** While this study focused on engineering, similar reflective practices could be beneficial across other STEM and non-STEM disciplines, especially in high-pressure academic environments.

Recommendations for Future Research

Future studies could explore the impact of failure journaling at different academic institutions and in various cultural contexts. Additionally, examining the long-term effects of journaling on students' professional development and post-graduate success would provide valuable insights. Quantitative studies with larger sample sizes could also complement these findings and offer more generalizable results.

7. Conclusion

This study set out to explore how structured failure journaling could support the development of resilience, reflective thinking, and adaptive learning behaviors among engineering students. The findings indicate that engaging regularly in reflective writing allows students to reframe their experiences with failure, not as moments of defeat but as opportunities for growth and self-discovery. Over the academic year, students demonstrated increased emotional regulation, improved coping strategies, and a greater willingness to confront and learn from challenges.

The journaling process helped students transition from a performance-oriented mindset to one that values personal development and learning through iteration. As students grew more comfortable articulating their struggles and analyzing their reactions, they became more self-aware and solution-focused. These reflective habits contributed not only to improved academic resilience but also to broader life skills that are essential for future engineers, such as critical thinking, emotional intelligence, and adaptability.

These outcomes suggest that failure journaling is a valuable yet underutilized pedagogical tool in engineering education. By creating space for emotional processing and intentional reflection, educators can support students in navigating the intense academic pressures common in STEM fields. Moreover, normalizing failure as part of the educational journey can foster a healthier,

RESEARCH CORRIDOR
Journal of Engineering Science

more innovative learning environment where students feel empowered to take risks and grow from their setbacks.

In light of these insights, there is a clear need for curriculum designers and faculty to consider integrating structured reflective practices, like failure journaling, into engineering programs. Doing so not only supports individual student development but also contributes to a cultural shift within engineering education—one that embraces failure as a stepping stone toward innovation, resilience, and long-term success.

References:

1. Anand, M. V., Abel, C., Sabuncu, A. C., & Sears, A. (2024, June). Embracing a Fail-Forward Mindset: Enhancing Engineering Innovation through Reflective Failure Journaling. In *2024 ASEE Annual Conference & Exposition*.
2. Bernold, L. E., Spurlin, J. E., & Anson, C. M. (2007). Understanding our students: A longitudinal-study of success and failure in engineering with implications for increased retention. *Journal of engineering education*, *96*(3), 263-274.
3. Simpson, E., Bradley, D., & O'Keeffe, J. (2018). Failure is an option: an innovative engineering curriculum. *International Journal of Building Pathology and Adaptation*, *36*(3), 268-282.
4. Bishop, K. (2017). Framing failure in the legal classroom: Techniques for encouraging growth and resilience. *Ark. L. rev.*, *70*, 959.
5. Corwin, L. A., & Charkoudian, L. K. (2022). *Confronting Failure: Approaches to Building Confidence and Resilience in Undergraduate Researchers*.
6. Lottero-Perdue, P. S., & Parry, E. A. (2017). Perspectives on failure in the classroom by elementary teachers new to teaching engineering. *Journal of Pre-College Engineering Education Research (J-PEER)*, *7*(1), 4.
7. Anand, M. V., & Frunzi, S. (2024). Empowering Innovation: A Study on the Effectiveness of a Two-Tier Hybrid Training for 3D Printing in a Makerspace.
8. Anand, M. V., Abel, C., Sabuncu, A. C., & Sears, A. (2024, June). Embracing a Fail-Forward Mindset: Enhancing Engineering Innovation through Reflective Failure Journaling. In 2024 ASEE Annual Conference & Exposition.
9. Anand, M. V., Abel, C., & Sabuncu, A. C. (2024, June). Cultivating Innovators—Unveiling the Hidden Potential of" Innovation Through Making" in Engineering Education. In 2024 ASEE Annual Conference & Exposition.
10. Daly, P., Anand, M. V., Abel, C., & Sabuncu, A. C. (2024, June). Industry Perspectives on Mechanical Engineering Troubleshooting. In 2024 ASEE Annual Conference & Exposition.