MISTAKE-BASED LEARNING ACROSS HIGH-RISK DISCIPLINES: AN AVALANCHE PROFESSIONAL DEVELOPMENT FRAMEWORK

J. Aaron Ball[1,2*]

1 Fort Lewis College, Durango, CO, USA
2 University of Idaho, Moscow, ID, USA

ABSTRACT: Snow avalanche professionals operate in wicked learning environments, where mistakes are inevitable due to feedback that is absent, inconsistent, or difficult to interpret. Mistakes in avalanche terrain can have catastrophic consequences, yet they are also vital for learning. This presents a fundamental challenge to effectively and safely develop the sensemaking and judgment practitioners need to operate in this high-risk, naturalistic work environment. Other disciplines grappling with this same problem can offer insights into how the learning value of mistakes can be leveraged without causing unacceptable harm.

This presentation reports findings from an integrative literature review synthesizing nine articles from military and medical communities of practice. Thematic analysis identified six mistake-based learning strategies and five associated instructional methods, though their application was not uniform across all learning settings. Instead, they were employed in different learning contexts defined by the severity of potential consequences and the degree of learner independence. Three learning contexts were identified: controlled learning environments, supervised practice, and high-stakes operations. These contexts reflect a spectrum of learning conditions, from structured training environments where consequences are controlled and supervision is intensive, to everyday workplace settings where the full range of consequences is possible and supervision is limited or absent. While novices are more often found at one end of this spectrum and experienced practitioners at the other, the contexts are defined by conditions rather than experience level. A first-year novice and a twenty-year veteran operating in the same high-stakes environment have access to the same learning strategies and methods.

From these findings, a framework was constructed that maps the identified learning strategies and methods to the three learning contexts, offering avalanche practitioners, trainers, and organizations a practical, context-aware tool for turning inevitable mistakes into deliberate learning opportunities at every stage of a professional avalanche career.

KEYWORDS: mistake-based learning; professional avalanche training; high-risk decision-making; wicked learning environment; learning context

1. INTRODUCTION

Avalanche professionals face a significant hazard that notoriously varies in predictability and can have severe consequences. Nearly every year, professionals such as guides, patrollers, and forecasters are killed while engaging with this hazard, and the incidence of non-fatal accidents is likely much higher, though most are unreported and their true number cannot be determined (Colorado Avalanche Information Center, n.d.). Managing risk for themselves, their peers, and those in their care is a distinct occupational challenge, and the ways practitioners make sense of situations and exercise judgment are key to this practice (Kahneman, 2011; McCammon, 2002; Weick, 1995).

Sensemaking and judgment are fundamental capacities necessary for professional avalanche work (Adams, 2005). Sensemaking is the process of identifying and interpreting ill-defined contexts (Weick, 1995), and judgment translates that understanding into an appropriate response (Wilderness Education Association, 2026). Both drive action and are informed by accumulated experience, pattern recognition, and mental models built over time (Dreyfus & Dreyfus, 2005; Klein, 1998).

* *Corresponding author address:*
J. Aaron Ball, Fort Lewis College,
Durango, CO 81301;
tel: +1 970-903-8355
email: ball_a@fortlewis.edu

All human knowing is embodied (Gärtner, 2013) and inseparable from the contexts in which it is developed (Lave & Wenger, 1991). Thus, authentic and physical engagement with the avalanche hazard is required to develop accurate sensemaking and judgment (Dreyfus & Dreyfus, 2005; Gärtner, 2013). This authentic engagement

is especially important for avalanche professionals, as their work environment often involves naturalistic conditions with limited time, high stakes, competing goals, and uncertainty (Klein et al., 1993). It takes many years to develop competence as an avalanche practitioner (LaChapelle, 2005) because these "wicked" learning environments often lack the predictive cues needed to recognize subtle, context-dependent patterns and to develop accurate mental models (Hogarth et al., 2015). For instance, when the likelihood of triggering an avalanche is either "unlikely" or "almost certain" (Statham et al., 2017), predictive cues are more prevalent and obvious, but when the likelihood is "possible" or "likely," predictive cues are less reliable and more difficult to interpret. Not only does this uncertainty make the work environment difficult to manage, but it also complicates a professional's ability to develop the requisite sensemaking and judgment as they progress through the arc of their career.

In these wicked learning environments, errors are inevitable. Yet, errors are also imperative to the development of expertise (Dreyfus & Dreyfus, 2005). Failure during learning disrupts automatic judgments and behaviors, prompting conscious reassessment of actions and yielding deeper understanding and more adaptable problem-solving (Dreyfus & Dreyfus, 2005; Sinha & Kapur, 2021). Although the first mistake may be their last in avalanche terrain, practitioners *will* err, and leveraging these mistakes to develop accurate sensemaking and judgment is critical.

This study examined existing knowledge on mistake-based learning strategies and instructional methods by synthesizing literature from other naturalistic, high-risk, and high-uncertainty disciplines. While frameworks exist that connect terrain selection with learning opportunities in avalanche instruction (Conger, 2021), the mistake-based learning strategies and instructional methods that develop the sensemaking and judgment these settings demand have not been systematically investigated. A learning strategy is a broad educational approach to promote learning, and an instructional method is an educational technique or procedure used to carry out those strategies. Although the literature draws finer distinctions between these terms (Reason, 1997), this review uses "mistake" and "error" somewhat interchangeably to represent the spectrum Reason describes, with the primary lens on mistakes arising from sensemaking and judgment. The questions guiding this review were: (1) What mistake-based learning strategies and instructional methods are employed with practitioners who operate in naturalistic, high-risk, and high-uncertainty disciplines? and (2) How might these strategies and methods be adapted for training and continuously developing avalanche professionals? A framework constructed from the findings may be adapted and used by avalanche educators, trainers, and organizational leaders to continuously develop avalanche professionals across the arc of their career.

2. METHODS

This integrative literature review synthesized knowledge on high-stakes mistake-based learning across communities of practice unrelated to professional avalanche work (Cronin & George, 2023). Over 200 databases were searched using distinct combinations of subject terms related to various cognitive dimensions, learning processes, error terms, and communities of practice. Key databases included APA PsycInfo, MEDLINE, and ERIC. Additional articles were identified through reference list screening, expert consultation, and the author's existing repository. The primary database search yielded 1,136 articles, with additional articles identified through the other sources. After applying the inclusion and exclusion criteria (Table 1), nine articles were retained for synthesis.

Table 1: Inclusion and exclusion criteria

Inclusion	***Exclusion***
Empirical research published in peer-reviewed academic journals printed in English	Editorial, commentary, summary, review, or theoretical articles, or articles not printed in English
Participant age ≥16 years	Participant age <16 years
Occurred in naturalistic settings	Occurred in classrooms or laboratories or involved only mental exercises
Focused on individual learning	Focused on group or organizational learning
Participants personally experienced the mistakes they learned from	Participants did not personally experience the mistakes they learned from

A staged review was conducted of all retrieved articles, and the included studies were thematically analyzed to identify similarities, differences, and relationships among practices (Cronin & George, 2023).

3. FINDINGS

Six mistake-based learning strategies and five instructional methods were identified across the nine reviewed studies and organized into three learning contexts (Figure 1). Identified across military and medical communities of practice, the learning contexts mirror those found in professional avalanche settings and are characterized by the severity of consequences and the degree of learner independence. While context may appear to correlate with a learner's level of experience, the developed framework is context-dependent rather than experience-dependent.

Controlled learning environments (CLE) are practice settings designed specifically for learning in which failure is deliberately allowed because significant consequences are absent and direct supervision can capture and correct errors. Simulated avalanche rescue practice commonly occurs in a CLE, as it typically involves non-avalanche terrain and direct trainer supervision.

In supervised practice (SP) contexts, learners engage in authentic tasks with real consequences under the direct supervision of a more experienced practitioner who provides a safety net for learning from mistakes. An experienced avalanche professional pursuing advanced training may find themselves in an SP context, traveling through consequential terrain under the supervision of someone with deeper expertise who can intervene if the likelihood of a serious consequence increases. The key characteristic of an SP context is increased learner independence, with the more experienced practitioner present only to prevent real harm and to maximize learning.

High-stakes operations (HSO) are authentic operational environments where errors can have serious real-world consequences for safety, performance, or outcomes. Working ski patrollers or avalanche forecasters performing their duties during normal operations have essentially full independence in their actions, and no supervisor is present to intervene. If an error occurs, no reset is possible.

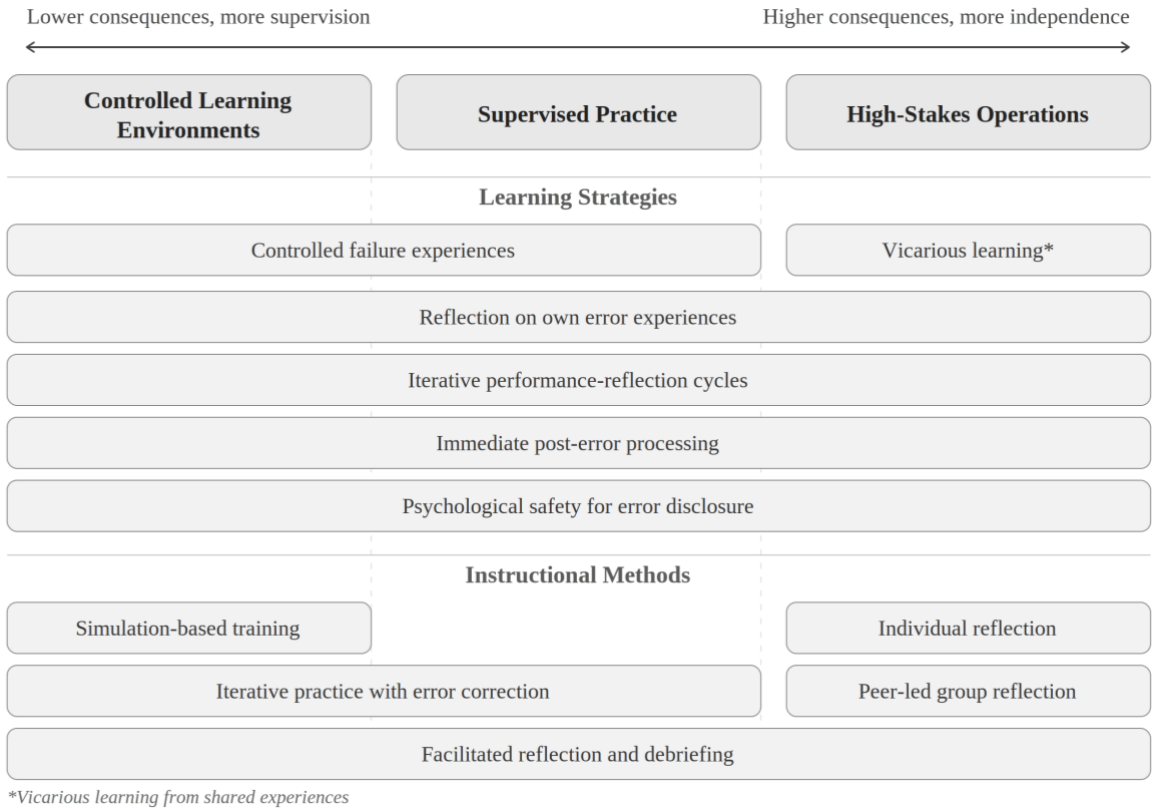

Figure 1: Mistake-based learning strategies and methods organized by learning context

3.1 Strategies and methods in Controlled Learning Environments

In CLE contexts, *controlled failure experiences* are intentionally designed activities where tasks exceed current capabilities, making struggle and failure expected outcomes. When this strategy was employed by Palominos et al. (2021, 2022)*, nursing students who struggled and failed during a pediatric simulation

* These citations refer to two separate analyses of the same study and will appear together throughout.

demonstrated deeper conceptual understanding on subsequent attempts. Two instructional methods support this strategy: *Simulation-based training* immerses learners in realistic scenarios that mirror operational demands while limiting real consequences. *Iterative practice with error correction* involves repeated engagement with essential skills, with errors identified and corrected between attempts. Together, these methods create learning experiences during which mistakes are safe and productive.

3.2 Strategies and methods in Supervised Practice

Controlled failure experiences are also used in SP contexts where the significance of a mistake is greater. Lynch et al. (2022) found that struggle and failure in real and consequential clinical settings under the guidance of a supervising physician challenged medical residents "to go beyond their routine strategies to generate new knowledge and solutions, thus enhancing their conceptual understanding and promoting adaptive expertise" (p. 1335). As in CLE contexts, *iterative practice with error correction* in SP contexts also involves repeatedly receiving feedback on errors made while engaging with important knowledge and skills, but the conditions surrounding the experiences are more complex, consequential, and difficult to anticipate.

3.3 Strategies and methods in High-Stakes Operations

In HSO contexts, learners engage with real operational hazards often without direct supervisory oversight, and this independence shapes the mistake-based strategies and methods available to them. Without attentive supervision, *vicarious learning from shared experiences* becomes invaluable. This strategy involves discussing and analyzing errors that occurred during shared operational experiences in which the learner was directly present. Hospital nurses reported that peer sharing of mistakes is essential for learning in their daily work (Bauer & Mulder, 2007), and military pilots learned from each other's errors during debriefings following shared missions (Catino & Patriotta, 2013; Firing et al., 2020; Ron et al., 2006). Two instructional methods are also exclusive to HSO contexts. *Individual reflection and self-directed learning* involves learners independently analyzing their errors and directing their own subsequent learning (Bauer & Mulder, 2007). *Peer-led group reflection and debriefing* is a collaborative discussion of error experiences facilitated by peers rather than a supervisor, exemplified by post-mission military debriefs, in which rank is disregarded and the process is frequently led by comparatively junior pilots (Firing et al., 2020; Ron et al., 2006).

3.4 Strategies and methods across contexts

Several strategies and methods appeared across all three learning contexts, suggesting that their utility is not contingent on the severity of consequences or learners' independence. The review identified four mistake-based learning strategies that crossed contexts: *reflection on own error experiences*, *iterative performance-reflection cycles*, *immediate post-error processing*, and *psychological safety for error disclosure*. The one cross-context instructional method was *facilitated reflection and debriefing*.

All nine articles discussed learners reflecting on their own errors, a process that ranged from informal and spontaneous to formal and structured. In SP and HSO contexts, reflection often occurred informally through impromptu interactions with peers and supervisors. Bauer and Mulder (2007) found that conversational debriefs with peers were powerful for learning, while Lynch et al. (2022) found that discussing a mistake with a supervisor and reflecting on what could have gone differently was among the most valuable learning opportunities available to medical residents. In contrast, structured and formal debriefs, found across all three contexts, were intentional, organized, and anticipated rather than spontaneous, such as post-flight debriefs in military aviation (Catino & Patriotta, 2013; Ron et al., 2006) and simulation debriefs in nursing education (Palominos et al., 2021, 2022). *Iterative performance-reflection cycles* are a related but distinct strategy, involving repeated opportunities to perform discipline-related tasks with reflection on errors between performances rather than a single isolated event. Timing also matters. *Immediate post-error processing* is a distinct but complementary strategy that capitalizes on temporal proximity, when details and emotions are fresh, and was observed in simulation debriefs (Palominos et al., 2021, 2022), military exercise debriefs (Catino & Patriotta, 2013; Ellis & Davidi, 2005; Firing et al., 2020; Ron et al., 2006), and post-fall huddles in hospital settings (Reiter-Palmon et al., 2015).

Psychological safety for error disclosure involves fostering a culture in which learners feel they can acknowledge, discuss, and learn from their mistakes without fear of punishment or judgment. In the Italian Air Force, Catino and Patriotta (2013) found that pilot identity was grounded in a safety culture in which reporting errors was treated as an ethical principle rather than an indicator of incompetence. In

SP contexts, Lynch et al. (2022) found that a supervisor's ability to model vulnerability and respond non-punitively to a mentee's mistakes was central to creating conditions for learning. Conversely, Catino and Patriotta (2013) and Firing et al. (2020) found that military pilots who feared reputational damage would sometimes conceal mistakes in HSO contexts, stunting opportunities for learning that can directly affect safety practices.

Facilitated reflection and debriefing is a structured reflection process guided by a supervisor, instructor, or more experienced practitioner in which learners analyze their errors, explore underlying causes, and develop alternative approaches for future action. Identified in four of the nine reviewed articles across all three learning contexts, this instructional method was implemented through structured simulation debriefs in CLE contexts (Palominos et al., 2021, 2022) and after-action reviews following navigation exercises and flight missions in SP and HSO contexts (Ellis & Davidi, 2005; Ron et al., 2006).

4. DISCUSSION

The identified learning strategies and instructional methods were organized into a three-learning-context framework that describes the conditions under which each has been employed across other naturalistic, high-risk, and high-uncertainty disciplines. The following discussion explains how this framework may be used to guide the training and development of avalanche professionals, which aligns with the perspective that the embodied sensemaking and judgment described earlier are inseparable from the real-world conditions under which that knowing develops (Dreyfus & Dreyfus, 2005; Gärtner, 2013; Lave & Wenger, 1991). While experienced practitioners may recognize many of these strategies and methods, this framework explicitly links their application to the learning contexts encountered throughout a professional avalanche career.

4.1 Mistake-based learning in CLE contexts

Although CLEs inherently lack the naturalistic characteristics of SP and HSO contexts, they are ideal for introducing concepts, building foundational skills, and refining technique. CLEs provide learners ample opportunities to err, making the following strategies and methods ideal for this context. Perhaps the most fitting mistake-based strategy for CLE contexts is to design learning experiences that stretch the edges of learners' competence (Sinha & Kapur, 2021). When implemented poorly, this strategy risks eroding confidence and being counterproductive (Bandura, 1997), so it is critical to frame errors as a normal part of the learning process (Palominos et al., 2022), encourage the adoption of a growth mindset (Dweck, 2006), and provide opportunities to also experience success (Ellis & Davidi, 2005).

These CLE-based stretch experiences, in which struggle and failure are intentional outcomes, are best implemented through simulations that mirror real-world operations. This instructional method is commonplace in professional avalanche training and typically follows an instruct-first, practice-second sequence. However, Palominos et al. (2021, 2022) observed that a practice-first, instruct-second structure ultimately led to deeper understanding and better performance in nursing students, so avalanche educators should consider flipping this progression.

CLEs also provide excellent opportunities for learners to receive detailed feedback and instruction after each attempt and apply it in subsequent performances. This cyclical process (Kolb, 1984) not only improves discipline-specific psychomotor skills (Ericsson et al., 1993) but also enhances the development of mental models and pattern recognition (Klein, 1998), making learner-specific error correction essential for developing competent avalanche professionals.

4.2 Mistake-based learning in SP contexts

The SP learning context arguably yields the greatest return for the learner by engaging with authentic conditions under supervision (Gärtner, 2013). Perceiving and interpreting important contextual cues, or understanding why cues are absent, requires repeated exposure, ideally with the input of an expert to help make sense of the wicked learning environments often associated with professional avalanche settings (Ericsson et al., 1993; Hogarth et al., 2015; LaChapelle, 2005; Lave & Wenger, 1991). However, because the level of uncertainty and the degree of consequence vary significantly across SP contexts, tight supervision is required, and close attention should be given to how these mistake-based strategies and methods are used.

Supervisors must seriously weigh an error’s educational value against its potential consequences when facilitating controlled failure experiences in SP contexts. When the risk is relatively low, such as when a trainer accompanies a guide-in-training leading a group through simple terrain under low avalanche

danger, certain mistakes may be permissible and require no immediate intervention. However, when a supervisor mentors a rookie patroller during avalanche control work, the elevated risk shrinks the window of allowable mistakes, and supervisors must be increasingly prepared to intervene before a mistake becomes serious. Effectively supervising an SP context requires expert-level sensemaking and judgment to continuously assess risk while monitoring a learner's decision-making, so supervisory roles should be assigned based on demonstrated ability rather than tenure or certification alone. When implemented thoughtfully, controlled failure experiences in SP contexts enable a quality of embodied learning neither CLEs nor HSOs can provide (Lynch et al., 2022).

SP contexts are less controlled and more complex than CLEs, but repeatedly practicing and receiving corrective feedback on errors remains an effective method for developing context-dependent mental models (Klein, 1998). Repeatedly perceiving, interpreting, deciding, and acting in naturalistic settings under the supervision of an experienced avalanche professional provides powerful opportunities to learn from errors if they are recognized and processed (Schön, 1983). To maximize the effectiveness of iterative practice, trainers and supervisors need to be prepared to capture and address even unexpected mistakes.

4.3 Mistake-based learning in HSO contexts

HSOs are where avalanche professionals spend most of their careers and, consequently, where LaChapelle's (2005) “ascending spiral” toward expertise primarily occurs. The embodied knowing that informs a practitioner’s sensemaking and judgment, developed over years of cumulative training and experience, cannot be fully realized in any other context. While CLEs can be used to build a practitioner’s foundational skills and SPs to develop more complex competencies, it is in HSOs that practitioners test and refine their craft.

It is imperative to learn from others’ mistakes in HSOs because the consequences of errors can be catastrophic. Embodied learning is most profound when the learner was present as the mistake unfolded (Gärtner, 2013; Lave & Wenger, 1991). Incident debriefs and end-of-day meetings are common in professional avalanche work and are powerful opportunities to learn from others’ mistakes (Catino & Patriotta, 2013; Firing et al., 2020; Ron et al., 2006). In practice, time pressure and other operational constraints can lead to these valuable debriefs and meetings being skipped, so practitioners should protect them against competing demands. Vicarious learning also occurs informally (Bauer & Mulder, 2007), as when a team of patrollers processes a mistake that occurred during an avalanche mitigation mission. Operations should deliberately provide the physical space and unstructured time that enable these impromptu interactions.

In HSOs, systems that rely on peer-to-peer processing are more common than in other learning contexts because there is often a lack of immediate, direct supervisory oversight. In these peer-led debriefs, collective knowledge and insight emerge through the team's shared sensemaking (Ron et al., 2006), but only when an open and honest culture allows competing interpretations to surface and be debated (Firing et al., 2020; Ron et al., 2006). Avalanche professionals can adopt rank-flattening practices, such as those common in military debriefs where removing rank insignia signals that all perspectives are equally valued (United States Army Combined Arms Center, 2013), to ensure the whole team contributes to learning from mistakes.

4.4 Mistake-based learning across contexts

Reflecting on one's errors is widely recognized as a critical element of learning (Kolb, 1984; Schön, 1983) and appeared across all nine reviewed studies in forms ranging from structured and formal to informal and spontaneous. How reflection appears across the three learning contexts is shaped by the nature of the environment, the desired outcomes, and the degree of supervision available. Structured reflection is common to all three contexts (Ellis & Davidi, 2005; Palominos et al., 2021, 2022; Ron et al., 2006) and should be intentionally facilitated with a clear purpose. In CLE contexts, structured reflection capitalizes on learning from a designed activity (Palominos et al., 2021, 2022), whereas in SP and HSO contexts, a structured reflective process can surface nuanced learning associated with mistakes and near-misses that might otherwise go unrecognized (Reason, 1997). Opportunities for informal reflection are also valuable and should be intentionally fostered, particularly in SP and HSO contexts (Bauer & Mulder, 2007), such as a guide-in-training sharing a car ride with a trainer at the end of a field day, or patrollers sharing downtime together at a patrol shack during the workday.

Iterative performance-reflection cycles are what ultimately drive learning (Kolb, 1984), and in professional avalanche work, the recurring pattern of operational days followed by debriefs exemplifies

this. However, repetition alone risks habituation, desensitizing practitioners to the meaningfulness of this routine (Catino & Patriotta, 2013), so avalanche operations must ensure that the quality of reflection between daily cycles remains high. Reflection's timing is also important. Immediate reflection capitalizes on the emotional arousal that follows an error before it fades (McGaugh, 2015) and, when combined with informative feedback, significantly improves practitioner performance (Ericsson et al., 1993). For avalanche professionals, the discipline of ending each day with structured reflection is therefore particularly important. Regardless of the form it takes, reflection must be deliberately designed into and encouraged across all learning contexts.

For meaningful growth to occur, errors must be disclosed and discussed openly (Schön, 1983). Cultivating a safe environment is an operation's responsibility rather than expecting learners to develop a resilience to critique on their own (Catino & Patriotta, 2013). This means mistakes should be framed as normal, anticipated outcomes in any learning context, thereby reducing anxiety and increasing learners' willingness to engage fully with challenging tasks (Palominos et al., 2022). Operations should also select trainers and supervisors based on their ability to model vulnerability and respond non-punitively, since the quality of their relationship with the learner directly shapes psychological safety across all three learning contexts (Lynch et al., 2022).

HSOs are perhaps the most difficult contexts in which to foster psychological safety, where avalanche professionals must be willing to openly disclose errors, even serious ones, without fear of judgment from peers or supervisors. Like military pilots, avalanche practitioners work in high-risk situations where perceived competence is central to professional identity (Reimer & Eriksen, 2025), creating conditions that can cause practitioners to conceal errors (Catino & Patriotta, 2013; Firing et al., 2020). While there will likely always be some tension between a practitioner's desire to contribute to a culture of learning and their need to protect their reputation (Firing et al., 2020), operations can help operationalize an ethical obligation to disclose by distinguishing good-faith errors, which go unpunished, from gross negligence or willful violations, which do not (Catino & Patriotta, 2013). Avalanche operations that foster a culture of inquiry, integrity, transparency, and accountability (Ron et al., 2006) create the conditions for genuine professional development across all three learning contexts.

Expert guidance can help learners connect actions to outcomes in ways that may not be apparent when reflecting independently (Dreyfus & Dreyfus, 2005; Schön, 1983). However, the facilitator's role shifts meaningfully across contexts, from interpreting errors in CLEs, to illuminating nuance in SP contexts, to eliciting collective knowledge in HSOs (Lynch et al., 2022; Reiter-Palmon et al., 2015; Ron et al., 2006). Avalanche practitioners in facilitation roles should be trained to adapt their approach to whatever the context demands.

5. CONCLUSION

Snow avalanche professionals make mistakes. It is an inevitable outcome of working in a wicked learning environment. Given what those mistakes can cost, every opportunity to learn from them should be capitalized on. This review synthesized nine articles from military and medical communities of practice to identify the strategies and methods these disciplines use to turn mistakes into learning. Findings were organized into a three-learning-context framework that accounts for the severity of possible consequences and the degree of learner independence. Controlled learning environments, supervised practice, and high-stakes operations reflect the learning contexts in which avalanche professionals work and develop throughout their careers. For practitioners, trainers, and organizations, this framework offers a practical, evidence-informed starting point for more intentional professional development. In an industry where mistakes can be fatal, these context-aware approaches to learning from mistakes matter.

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REFERENCES

Adams, P. W. G., 2005. A systems approach to human factors and expert decision-making within Canadian avalanche phenomena [Unpublished doctoral dissertation]. University of Calgary.

Bandura, A., 1997. Self-efficacy: The exercise of control. W. H. Freeman.

Bauer, J., Mulder, R. H., 2007. Modelling learning from errors in daily work. Learning in Health and Social Care, 6, 121–133, https://doi.org/10.1111/j.1473-6861.2007.00150.x

Catino, M., Patriotta, G., 2013. Learning from errors: Cognition, emotions and safety culture in the Italian Air Force. Organization Studies, 34, 437–467, https://doi.org/10.1177/0170840612467156

Colorado Avalanche Information Center, n.d. Statistics and reporting. Retrieved from https://avalanche.state.co.us/accidents/statistics-and-reporting

Conger, S., 2021. Good terrain selection for avalanche instruction: Making the best of the situation. The Avalanche Review, 40, 17.

Cronin, M. A., George, E., 2023. The why and how of the integrative review. Organizational Research Methods, 26, 168–192, https://doi.org/10.1177/1094428120935507

Dreyfus, H. L., Dreyfus, S. E., 2005. Peripheral vision: Expertise in real world contexts. Organization Studies, 26, 779–792, https://doi.org/10.1177/0170840605053102

Dweck, C. S., 2006. Mindset: The new psychology of success. Random House.

Ellis, S., Davidi, I., 2005. After-event reviews: Drawing lessons from successful and failed experience. Journal of Applied Psychology, 90, 857–871, https://doi.org/10.1037/0021-9010.90.5.857

Ericsson, K. A., Krampe, R. T., Tesch-Römer, C., 1993. The role of deliberate practice in the acquisition of expert performance. Psychological Review, 100, 363–406, https://doi.org/10.1037/0033-295X.100.3.363

Firing, K., Owesen, V., Moen, F., 2020. Organizational learning through debriefing: The process of sharing and hiding knowledge. Scandinavian Journal of Military Studies, 3, 169–182, https://doi.org/10.31374/sjms.54

Gärtner, C., 2013. Cognition, knowing and learning in the flesh: Six views on embodied knowing in organization studies. Scandinavian Journal of Management, 29, 338–352, https://doi.org/10.1016/j.scaman.2013.07.005

Hogarth, R. M., Lejarraga, T., Soyer, E., 2015. The two settings of kind and wicked learning environments. Current Directions in Psychological Science, 24, 379–385, https://doi.org/10.1177/0963721415591878

Kahneman, D., 2011. Thinking, fast and slow. Farrar, Straus and Giroux.

Klein, G., 1998. Sources of power: How people make decisions. MIT Press.

Klein, G. A., Orasanu, J., Calderwood, R., Zsambok, C. E. (Eds.), 1993. Decision making in action: Models and methods. Ablex Publishing.

Kolb, D., 1984. Experiential learning: Experience as the source of learning and development. Prentice-Hall.

LaChapelle, E. R., 2005. The ascending spiral. The Avalanche Review, 24, 16–17.

Lave, J., Wenger, E., 1991. Situated learning: Legitimate peripheral participation. Cambridge University Press.

Lynch, J., Orsino, A., Kawamura, A., 2022. Productive struggle and failing safely: Implications for developing adaptive expertise in communication. Advances in Health Sciences Education, 27, 1331–1344, https://doi.org/10.1007/s10459-022-10175-x

McCammon, I., 2002. Evidence of heuristic traps in recreational avalanche accidents. Proceedings of the International Snow Science Workshop, Penticton, Canada, 1–8.

McGaugh, J. L., 2015. Consolidating memories. Annual Review of Psychology, 66, 1–24, https://doi.org/10.1146/annurev-psych-010814-014954

Palominos, E., Levett-Jones, T., Power, T., Alcorn, N., Martinez-Maldonado, R., 2021. Measuring the impact of productive failure on nursing students' learning in healthcare simulation: A quasi-experimental study. Nurse Education Today, 101, 104871, https://doi.org/10.1016/j.nedt.2021.104871

Palominos, E., Levett-Jones, T., Power, T., Martinez-Maldonado, R., 2022. 'We learn from our mistakes': Nursing students' perceptions of a productive failure simulation. Collegian, 29, 708–712, https://doi.org/10.1016/j.colegn.2022.02.006

Reason, J., 1997. Managing the risks of organizational accidents. Ashgate Publishing.

Reimer, R. D., Eriksen, C., 2025. Feeling safe enough: Psychological safety in the mountain guiding and avalanche profession. Journal of Rural Studies, 120, Article 103834, https://doi.org/10.1016/j.jrurstud.2025.103834

Reiter-Palmon, R., Kennel, V., Allen, J. A., Jones, K. J., Skinner, A. M., 2015. Naturalistic decision making in after-action review meetings: The implementation of and learning from post-fall huddles. Journal of Occupational and Organizational Psychology, 88, 322–340, https://doi.org/10.1111/joop.12084

Ron, N., Lipshitz, R., Popper, M., 2006. How organizations learn: Post-flight reviews in an F-16 fighter squadron. Organization Studies, 27, 1069–1089, https://doi.org/10.1177/0170840606064567

Schön, D. A., 1983. The reflective practitioner: How professionals think in action. Basic Books.

Sinha, T., Kapur, M., 2021. When problem solving followed by instruction works: Evidence for productive failure. Review of Educational Research, 91, 761–798, https://doi.org/10.3102/00346543211019105

Statham, G., Haegeli, P., Greene, E., Birkeland, K., Israelson, C., Tremper, B., Stethem, C., McMahon, B., White, B., Kelly, J., 2017. A conceptual model of avalanche hazard. Natural Hazards, 90, 663–691, https://doi.org/10.1007/s11069-017-3070-5

United States Army Combined Arms Center, 2013. The leader's guide to after-action reviews (AAR). United States Army.

Weick, K. E., 1995. Sensemaking in organizations. Sage Publications.

Wilderness Education Association, 2026. Judgment. https://www.weainfo.org/standards-judgment