

## BURIED ALIVE: A QUALITATIVE STUDY OF AVALANCHE SURVIVORS' LEARNING EXPERIENCE AFTER AN AVALANCHE ACCIDENT

Audun Hetland<sup>1\*</sup>, Tarjei Skille<sup>1</sup>, Andrea Mannberg<sup>1</sup>, Thea Kristensen<sup>1</sup>, Iselin Hjelm<sup>1</sup>

<sup>1</sup> Center for Avalanche Research and Education, UiT The Arctic University of Norway, Tromsø, Norway

**ABSTRACT:** Avalanche terrain offers a challenging learning environment due to the potentially misleading and often absent feedback from the terrain itself. This study provides a comprehensive exploration of backcountry riders' experiences with avalanches. Through a qualitative approach we aimed to understand victims' personal experiences and learning processes. A group of 26 avalanche survivors participated in semi-structured interviews, sharing their accident experiences. The study utilized a phenomenological method, with data analyzed through a thematic approach. Participants reported heightened risk awareness and emotional shifts that appeared to result in more deliberate risk assessments, new preferences, and increased recognition of their own cognitive biases following the avalanche incident. The findings highlight that these personal experiences led to significant learning outcomes, prompting several adaptive changes in behavior and decision-making.

**KEYWORDS:** Avalanche accident, decision-making, learning, experiential learning

### INTRODUCTION

9 out of 10 of fatal avalanche accidents are triggered by the victim or someone in their group (McClung and Schaerer, 2006; Schweizer and Lüttschg, 2001). This has spurred increased interest in the human factors contributing to avalanches (McCammon, 2009), as understanding decision-making and actions can help prevent such accidents (Brattlien, 2014; McCammon, 2000)..

Logan and Atkins (1996) argue that many avalanche incidents could be prevented, as the same mistakes are often repeated by different individuals. However, 38% of individuals who experience an avalanche get caught in subsequent avalanches (Johnson et al., 2020). This raises questions about the experiences and insights gained by avalanche survivors and how they apply this knowledge when they return to the mountains.

Even though avalanche education is shown to influence risk perception and provide practical knowledge (Greene et al., 2022), avalanche victims typically possess the skills to make informed choices (Johnson et al., 2020). For instance, most avalanche victims in Norway over the past five years were somewhat to very experienced (Aasen, 2019). This suggests that judgement, not necessarily knowledge, is often the problem (Atkins, 2000). Suboptimal judgements is leading people to misinterpret,

overlook, or overestimate their ability to assess avalanche risk, falling prey to overconfidence and heuristic traps (Johnson et al., 2020).

This study explores what and how people learn from their avalanche experiences by investigating individuals who have received direct feedback from such events.

#### 1.1 *Experiential Learning in a Wicked Learning Environment*

Learning is crucial for survival, involving skill development, behavior correction, and knowledge updating through reliable feedback (Ellis et al., 2014). In environments like avalanche terrain, where feedback can be minimal or misleading, experiential learning becomes challenging (Hogarth et al., 2015). Kolb's (2014) model of experiential learning emphasizes using decision outcomes to inform better future decisions. However, people often resist changing their mental models until they face significant negative outcomes (Argyris, 1986).

In avalanche terrain, decision-makers discover the outcomes of their choices, but not the potential outcomes of alternatives. Positive experiences from good skiing reinforce risky behaviors, increasing the likelihood of repeating them (Fazey et al., 2005). This can create false confidence in risk management skills because correct decisions may result from luck rather than skill.

#### 1.2 *Two Ways of Learning*

Humans learn in two primary ways: from personal experience and from descriptions, a capability unique to humans. Descriptive learning allows humans to spread knowledge globally (Boyd and

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\* Corresponding author address:

Audun Hetland CARE - Center for Avalanche Research and Education, UiT The Arctic University of Norway  
tel: +4793041612  
email: [audun.hetland@uit.no](mailto:audun.hetland@uit.no)

Richerson, 2005), summarizing collective experiences into effective information (Frey et al., 2021). It enables learning from others' mistakes and imagining unexperienced events (Gregory et al., 1982). However, experience often precedes descriptions in decision-making, especially in complex tasks like avalanche assessments (Erev et al., 2017; Weiss-Cohen et al., 2016).

Experience-based learning includes cognitive and emotional components that description-based learning lacks (Hertwig et al., 2018). Emotions significantly impact decision-making (Loewenstein, 2003), leading to different outcomes from these learning modes, known as the descriptive-experience gap (Hertwig et al., 2004).

Understanding how individuals think, behave, and feel after an avalanche is crucial, as positive experiences can reinforce risky behaviors while negative experiences can deter them (Denrell and March, 2001).

### 1.3 Purpose and Research Questions

Despite understanding why avalanche accidents occur, there is limited research on how individuals reflect on these accidents and the subsequent effects on their thoughts, emotions, and behaviors. The powerful negative feedback from surviving an avalanche prompts questions about the lasting impact on survivors' decision-making and behavior. We aim to answer two research questions: 1) What changes does an avalanche accident lead to in terms of learning, risk and decision making? 2) What do survivors experience when returning to the backcountry after the accident?

## 2. METHOD

Given the exploratory nature of this study, we use personal in-depth interviews to answer our research questions. The qualitative approach allows us to gain a deeper investigation of participants' thoughts, behaviors, emotions, and backgrounds, and therefore well-suited to uncover the meaning of people's experiences (Kvale and Brinkmann, 2015).

We adopt a phenomenological approach to explore participants' experiences and how they make meaning of these experiences (Edmonds and Kennedy, 2016). This approach emphasizes openness to participants' reflections and recognizes them as experts on their own experiences. The interviews were semi-structured and guided by a protocol (see [osf.io/u4sfe/](https://osf.io/u4sfe/)). This ensured consistency across interviews and allowed exploration of emerging themes.

### 2.1 Participants

Twenty-six participants, recruited in autumn 2022, participated in the study (25 males and 1 female). Participants had direct or indirect experience with avalanches, either having been caught in an avalanche themselves or being part of a group where others were caught. Most were off-piste and backcountry skiers from Norway. One participant had experience of a snowmobile accident.

We primarily recruited participants from the CARE panel, a cohort study with 3200 backcountry skiers. Of the 52 panelists that had previous experience of accidents resulting in complete burial, injury, or death in 2022, 18 agreed to be interviewed. Eight additional participants were recruited through snowball sampling and social media outreach.

### 2.2 Interview guide

The interview guide was designed to cover core themes. Participants were first asked to describe their avalanche experience in detail to trigger their thought processes and recall incident details. Follow-up questions addressed decision-making, emotions, thoughts, risk evaluation, behavior, and group dynamics. Participants were also asked to share tips for other skiers and reflect on lessons learned from their accidents (see <https://osf.io/u4sfe/>).

### 2.3 Interviews

We conducted the interviews in August, September, and October 2022. The interviews lasted from 20 minutes to two hours, with most around an hour.

### 2.4 Ethics

The project was approved by the Norwegian Centre for Research and Data (NSD-733888). Participants were informed about anonymity and data confidentiality and signed a consent form. They were assured they could withdraw at any time.

### 2.5 Analytical procedure

We used the phenomenological approach described by Brinkman and Kvale (2015), to explore participants' personal understandings of their avalanche accidents. Participants described the process from planning to the accident and their learning outcomes. We employed a thematic analysis with an abductive approach to extract meaning by categorizing data and identifying themes, which were then quality checked by others on the team. All interviews were audio recorded and transcribed. The transcribed material

was divided into meaning units and condensed to create a structured overview of the data. Condensed meaning units were uploaded to NVivo 12 software. Common features were identified, and descriptive codes were created to capture the essence of the themes. We divided the main codes into categories and sub-categories. Relevant quotes describing the themes were identified and translated from Norwegian to English. Finally, we created a table with abstracted themes and sub-themes summarizing the findings from the data.

### 3. RESULTS

The majority of participants in this study had experienced severe avalanche accidents. Nearly half (N=12) participants were in accidents involving fatalities or hospitalization of one or more of the members. Another seven participants reported injuries needing medical treatment. In only five of the avalanches the participants were able to walk away physically unharmed. The data collection resulted in substantial material with nuanced themes and subthemes. Two main themes emerged: participants' changed experiences and behavior when returning to the mountains (3.1-3.4), and reflections on the avalanche accident as a learning experience (3.5-3.6). These main themes contained several subthemes, supported by direct quotations translated from Norwegian to English.

#### 3.1 *Risk perspective*

The interview material highlights the descriptive - experience gap and show that experiences of avalanches serve as a **reality check** that improves **risk awareness** and **understanding of avalanche risk** and the **consequences of being caught**. People without accident experience can have an abstract understanding of the risk and consequences of an avalanche. Experiencing an avalanche makes the danger tangible and real.

*"It is different to see the powers live in action. It is different from just hearing about it and thinking about it. In that moment, when I was caught by the avalanche, I thought now it's my turn to die. This is it... I am actually going to die."*

*"I look at the terrain differently now. I am always thinking what if there is an avalanche here... thinking about the consequences if it releases here."*

The heightened awareness of avalanche risk affects decisions in avalanche terrain. While many informants say that their **willingness to take risks** remain the same, they nonetheless express that they now expose themselves to less avalanche risk. Some informants attribute this directly to the accident, while others attribute it to

increased age, more experience and other life changes. The two quotes below exemplify.

*"Now I wouldn't have taken that risk. I think it's a bit about the feeling of being invulnerable that you can... that at least I had before. Thinking it won't happen to me. I don't think that anymore."*

*"It (risk-taking) has changed over the years. At the time we were without kids and in a different life situation. So, it has become more conservative now."*

Participants who maintain their risk levels report that they have gained an increased understanding of the uncertainty of avalanche risk, and that they therefore take better-calculated risk.

*"It has not changed my willingness to take risk as I might even take more risk now by skiing in high consequence terrain, but it has changed my understanding of risk, the awareness around it."*

All participants in this study continued skiing. Their experiences differed, but several of the participants explained that the joy of skiing outweighs potential negative outcomes.

*"I fear that the experience of being in the mountains, the feeling of untouched powder is so amazing that it outshines all... or in many cases the potential risk that lies behind it so that it sorts of gets disguised."*

#### 3.2 *Changes in decision making*

The interviews highlight several changes in the participants decision making process. The participants report being more focused on **updating** and being more attentive to **specific cues** closely monitoring terrain traps, weather, temperature and snowpack.

*"It (avalanche accident) has shown me... or reminded me that my ability to take in or read the warning signals are not good enough, and that you have to spend more time, you must look."*

*"I am much more skeptical to steep terrain and more focused on runout zones. Especially these hanging wind packed areas... you are going to be so much more attentive to it."*

This, the participants argue, **improves the quality** of their decisions and provide them with a **better overview of the situation**.

*"I think that I am better at working with the information that's around me and available to me in avalanche terrain. And I work much more systematically with this information to make good decisions."*

*"When you take the wrong route further down, you expose yourself to a large risk as you don't have a complete overview of the mountain. That*

*was an important lesson for me, to have this complete overview."*

The experience of an avalanche accident increases awareness of **pre-trip planning**. The participants report that they check weather, maps, and avalanche forecasts in greater detail than prior to the accident.

*"I spend more time looking at and updating my knowledge about how the weather is and how it has been. So, it's an ongoing collection of weather observations."*

The participants further display more consequence thinking and preventive actions, such as using first aid gear, wearing helmets, and being aware of hypothermia risks and cellphone service.

*"I am always thinking what if there is an avalanche here (...). So, helmet, maybe a jacket, thinking about hypothermia and stuff. So not just necessarily focus on the snow but also more trauma preventing practices."*

*"You must have a constant awareness of where you are, where you are going and the consequences of being there."*

### 3.3 Emotional aftereffects and behavioral consequences

Even though all the participants had experienced serious avalanche accidents there were differences in the severeness, where some had lost friends or acquired lasting injuries while others were luckier. As may be expected, the participants also report a difference in the emotional aftereffects, where a minority experienced various degrees of trauma, including panic and strong fear related to the terrain and sounds that reminded them of the avalanche. Some describe nightmares and panic attacks. To deal with the aftereffects, many participants used self-induced exposure therapy to regain comfort in the mountains.

*"A couple of years after the avalanche I was very determined to do this self-imposed exposure therapy... I dreamt a lot about it for a couple of years. Those years were really hard."*

However, most of the participants did not experience severe aftereffects but still report more frequent feelings of discomfort, unease, or fear, especially in the terrain where the avalanche occurred.

*"After the avalanche accident, I didn't feel any more fear compared to before the accident. But it's more of this feeling of being in a couloir, that is something I would really dread going into."*

These changes in emotions significantly influence their judgment and decision-making, often guided by gut feelings.

*"I hope that there is something that will make my stomach hurt, so then I'll figure out that today it's not worth it or I'm not doing it."*

Nearly half of the participants say that they reduced or stopped skiing in avalanche terrain, particularly in the years immediately following the accident. Participants associate changes in behavior with perceived safety in different terrains, particularly terrain like the one they were caught in.

*"I dread going into big couloirs. Because you are so committed when entering those... I haven't skied any big couloirs. I dread that."*

One participant, who was caught on a large flank, describes avoiding this type of terrain.

*"I ski much more in the forest and smaller terrain. I wish I could ski more big and open terrain, but I am more afraid of that."*

Another participant, who was caught in the forest, experience fear of treed terrain.

*"The forest looks safe. But it is not safe at all if there is released an avalanche there. And the trees do not have to be big before they hurt when you hit them. So that's mainly my lessons from it."*

Some prefer skiing late in the spring to avoid conditions like those during their accident.

*"I am more able to wait until the spring to ski the very steep stuff."*

However, it is worth noting that the Arctic spring does not automatically mean safe skiing conditions. Indeed, the majority of the avalanche accidents occurs in March and April, and even May.

*"I always had this relaxed relationship to spring conditions. Because then you can let loose and ski steeper. But that has changed."*

The participants describe that the feelings of fear and unease has led them to turn around more often, and made them feel more comfortable in making this decision due to increased risk awareness and potential consequences.

*"On a trip this winter we were supposed to ride a steep line. I felt like, no this does not feel right today. I am going to save it for another day."*

### 3.4 Awareness of Mental Fallacies and Misjudgments

Almost all participants reflect on increased awareness of their mental fallacies post-accident. They recognize how feeling safe, lack of awareness, and strong desires to ski influenced their decision-making.

*"You get so, oh you really want to ski there, and you see everybody else skiing all kinds of things. People ski all sorts of weird things all the time. Nothing happens to them, it's completely fine, so then let me have my fun too."*

Participants link their reflections on misjudgments to their accident characteristics and outlined solutions to prevent similar errors. Some created pre-trip rules to avoid being swayed by their desires. Others adopt flexible mindsets or plans, allowing for safer terrain choices.

*"I hope I wouldn't do the same again, that I am more aware. I think I am more aware not to mess up."*

However, even though they take measures to correct misjudgments they still express self-doubt, acknowledging that their wish to ski sometimes overrules the available cues, leading to risky decisions.

*"It was just my wish to ski was overruling the cues available to me. So that part scares me, and it has made me doubt myself."*

### 3.5 The link between self-perceived learning and the pre-accident evaluations of risk

Eight participants feel that their decision-making abilities in avalanche terrain have improved after the accident, while thirteen describe feeling less confident in their decision-making skills now. The difference in perception of abilities can be linked to whether or not the participant had a bad feeling prior to the accident or if they actively evaluated the situation and thought that they made the right decision.

*"The avalanche really just confirmed what we were scared of that day. Exactly what we were scared of actually... so yes, I do feel more confident in my own avalanche assessments."*

*"I think things would have changed a lot more, and I would have doubted my own decisions afterwards if I had made an active decision that I felt was right in that situation and still ended up in the accident."*

Participants who did not experience a warning express more self-doubt and skepticism towards their evaluations.

*"You are a bit more sceptical to your own evaluations all the time... So, there was a time afterwards where you doubt yourself all the time."*

Nearly half of the participants state that the accident experience has made them seek more knowledge to improve their decision-making.

*"When you get this reprimand so early in your skiing career it affected me to spend more time acquiring knowledge about being in avalanche terrain."*

### 3.6 Awareness of group dynamics and interest in learning and sharing.

Nearly all participants report changes in who they go touring with, emphasizing the importance of clear responsibility and communication within the group. They prefer skiing with individuals trained in rescue and with similar attitudes towards risk.

*"It has changed everything really... who I go with, where, and how many... it's a lot about personality, skiing abilities, knowledge, and attitude."*

Perhaps surprisingly, nearly half of the participants view their avalanche accident as a positive and significant learning experience. Some note that their learning is intertwined with age and experience.

*"Yes, it has changed a lot. It has made me interested in everything that has to do with skiing really... My backpack probably weighs 10 kilos more now than it did back then."*

Nearly half of the participants emphasize the importance of discussing the avalanche experience for acceptance and reflection.

*"That debrief was the absolute best thing to do after a situation like that... it opens your mindset and prevents you from getting trapped in your own head."*

While some find sharing painful, most participants feel it is important for others to learn from their experiences.

*"I am happy I can share my experience at least... there is no use in learning from it if one can't share the lessons."*

*"I managed to analyze my way to why it went wrong because then you can learn from your mistakes."*

However, it should perhaps be noted that not all participants see the accident as a learning experience. Some feel that they have completely lost confidence in their decision-making ability and others feel that that the accident was a random natural event. Neither of these groups describe engaging in introspection and behavioural change.

## 4. DISCUSSION

This study aimed to explore how avalanche victims reflect on their accidents in terms of learning. Participants' statements highlight varied personal perceptions and learning outcomes from their accidents. Most describe increased risk awareness and emotional changes leading to more conscious risk assessments, new preferences, and awareness of mental fallacies. Participants further report increased knowledge-seeking, new perspectives on their abilities, awareness of group dynamics and consequences, and enhanced planning and attentiveness.

Most participants feel that accident analysis, reflection, and debriefing was central to their healing and learning process. Many have found it meaningful to share their experiences. The following sections discuss the new perspectives on risk, different interpretations of contributing factors, changes in behavior, and the importance of reflection and shared knowledge.

### 4.1 A new perspective on risk

Many participants report that they were aware of the risks prior to the accident, but that the risk was abstract and hypothetical. The avalanche accident made the risks real and tangible, and many experience feelings of unease or even panic in situations when they are exposed to avalanche risk post-accident. This aligns with research indicating that learning from experience differs significantly from learning from descriptions, leading to different decision-making processes (Frey et al., 2021). Perhaps most importantly, personal experiences affect us more emotionally, and therefore often leads to more reflection. In our data, we can see that experience of an avalanche accident affects risk perception (both the risk of an avalanche and the consequences of being caught), and that the heightened risk awareness leads to behavioral change in terms of more pre-trip planning, a more continuous information updating, more flexible route plans, and an increased attention to group processes. This aligns with previous studies showing that risk perception significantly influences risk exposure (Weber and Milliman, 1997).

The participants' post-accident decision-process further resembles how professional guides make decisions at work (Løland et al., 2023).

In their ethnographic study on guides, Løland and Hällgren (2023) found that professional guides evaluate the group and the current avalanche conditions before choosing where to ski, and seek mountains where there are several different alternative routes that they may fall back on if the con-

ditions are less favorable than expected. In a similar study on non-experts Michaelsen et al. (2024) found non-experts to have a reversed pattern with fixed goal, inattentive to current conditions and unwilling to update their information. Summarized it seems that the avalanche accident changes the participants decision-making process in the direction of the one of experts.

### 4.2 The new perspective on risk may be skewed. "The hot stove effect"

Most participants link their accidents to specific weather, snow conditions, or terrain, leading to increased awareness and negative emotions towards these cues, but still feel relatively safe in other types of terrain or in other conditions. This aligns with the "hot stove effect," where negative outcomes decrease the frequency of associated behaviors (Denrell and March, 2001). Such focus on cues may decrease future risk. However, the "hot stove effect" also predicts a negativity bias towards specific activities or cues that has produced a negative outcome. This can lead to a false sense of security and potentially dangerous situations if they underestimate risks in new terrains. Low feedback environments may continue to prevent updating these interpretations, reinforcing misperceptions (Denrell & March, 2001). In our study, we find that even though the accident experience makes participants more attentive to certain cues, these cues may not objectively represent the current risk. While several participants shy away from the specific terrain characteristics of their accident, they do not transfer their new risk perception to other forms of potentially dangerous terrain. For example, we find that participants caught on open slopes seek the forest, and participants caught in the forest seek more open terrain.

Previous studies suggest that risk aversion may decrease over time after an accident, with risky behaviors rebounding within months, although psychological distress may persist for years (Hertwig and Wulff, 2022). Participants' statements indicate that their avoidant behaviors and emotions often fade with repeated exposure to cues. This may be one explanation to why many skiers get avalanched repeatedly (Johnson et al 2020). Future research could explore how mental models of risk evolve over time and exposure.

We would like to highlight that all participants in this study continued skiing after their accidents. This suggests that their risk profiles might differ from those who quit. As a consequence, our study does not fully describe the effects of a serious accident. Further research could explore this aspect by involving participants who stopped skiing after their accident.

### 4.3 Interpreting the accident

Previous studies show that people who experience an internal locus of control, i.e., perceive that they affect the outcome, feel more responsible for the outcome and are more likely to make behavioral changes after an adverse experience. Conversely, those with an external locus blame external factors and may not adapt as effectively (Findley and Cooper, 1983). In our study we find that, while many participants attribute the accident to their own (lack of) judgement and skills, or to group factors, other see the accident more as a random event. Our analysis suggests a link between causal attribution and learning. Participants who acknowledged their mental fallacies developed rules to control decision-making and maintained an open mindset. Awareness of biases and overcoming them are crucial parts of avalanche training. By contrast, participants who attributed the accident to bad luck focused more on risk mitigation that reduce consequences of random risk (e.g. first aid) and less on introspection and learning. Interpreting avalanches as random events might reduce efforts to assess relevant factors in future trips, missing broader learning opportunities.

It should be noted that internal locus of control does not guarantee learning. Some participants experienced gut feelings warning them of potential danger before the accident. Trusting these emotional cues may be important, but over-reliance can hinder analytical approaches crucial in ambiguous environments. Particularly relying on the absence of a negative gut feeling as an argument to ski is dangerous in a low feedback environment.

### 4.4 Reflection as a part of the learning process

Reflection is essential for mental well-being and learning (Kolb, 2014; Pennebaker, 2000). One participant talked about his accident to be able to accept it, while another analyzed it to understand what went wrong and prevent future incidents. Reviewing experiences, considering different perspectives, and creating a comprehensive understanding, has been found to improve decision-making (Weick and Sutcliffe, 2001). In addition, open reflections, where the individual assesses and evaluates his or her own skills, is open to criticism, and reflects on situations without extreme outcomes are at the core of a good learning culture (Hertwig and Wulff, 2022; Landrø et al., 2022; Norman et al., 2019). Sharing insights within a group can facilitate collective learning and help individuals gain skills without the associated risks (Fazey et al., 2005). Learning from

others' experiences is vital for human development (Boyd and Richerson, 2005; Frey et al., 2021). The more of an experience and less of a description the broader and deeper people learn. Vicarious approaches or "simulated experiences" might therefore be more effective than simple descriptions of risk in avalanche education (Hertwig and Wulff, 2022; Skversky-Blocq et al., 2021). The community should create safe environments for sharing experiences without judgment to foster this learning culture.

### 4.5 Limitations

The study's qualitative phenomenological approach has limitations, including biases in retrospective reporting and researchers' interpretations (Holloway and Galvin, 2023). Time since accidents varied, affecting reflections and potential post-rationalization (Kahneman and Riis, 2005). Different experience levels among participants may lead to varied learning outcomes, with a gender-skewed sample of mainly Norwegians. Online interviews are in general shorter and less personal. The requirement for CARE-panel responses might have skewed the sample. Despite striving for quality, interviewers' level of experience and participants' personalities impacted results. Future research should include those who stopped skiing post-accident to understand differing outcomes.

## 5. CONCLUSION

The study provides an exploratory overview of learning processes and aftereffects for avalanche victims. Participants reported increased awareness of risk, misjudgments, and consequences, along with enhanced planning, attentiveness, and information updating. They also sought more knowledge and gained new perspectives on their abilities and group dynamics. While some participants showed adaptive changes, others had varied interpretations and thought processes, suggesting that learning outcomes are not uniform. The study emphasizes the importance of open reflection and sharing of experiences within the backcountry community to foster better decision-making and prevent future accidents.

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