# LEARNING ON THE MOUNTAIN: WHAT GETS OUR ATTENTION AND HOW MIGHT REFLECTING ON THAT CHANGE OUR WAYS?

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ABSTRACT: She sets her poles down, turns her skis, drops with a rush of adrenaline, and floats down the chute. Backcountry skiers in avalanche terrain navigate a fine line between joy, extreme arousal, and potential death. The mountain, unpredictable by nature, serves as a wicked learning environment with uncertain feedback for those venturing onto its slopes. With this as a learning stage, avalanche courses not only need to teach people hard skills, but also skills for becoming lifelong reflective practitioners. Can avalanche courses designed to stimulate double-loop learning help even nonprofes-sionals master reflective practice? In this study we investigated if this could be achieved through dis-locatory moments, where skiers encounter discrepancies between their established practices and other practices, views or guiding values that they reflect upon post-trip. During a season-long avalanche course with 11 practical days, 10 participants with moderate skills used the Reflectometer, a novel tool, to capture and reflect on decisive points for learning. Our study analyzes these learning moments to identify dislocatory moments and their triggers using a qualitative thematic approach and an iterative process. The Reflectometer recorded 90 dislocatory moments that occurred within the themes of Snow, Gear, Group Dynamics, Communication, and Emotional Dynamics. Fiftytwo of these moments showed signs of stimulating double-loop learning. An analysis of the learning stimulated by dislocatory moments indicates how such moments can enhance reflective practices. Implications for both theory and practice are discussed.

KEYWORDS: Reflective learning, double-loop learning, avalanche education, dislocatory moments, wicked learning environment

## 1. INTRODUCTION

Back-country skiing attracts those seeking fresh snow beyond the bonds of ski resorts. It offers emotional release, stress escape, and a deep connection to nature. Navigating challenging terrain can evoke vertigo, thrill, and excitement. However, back-country skiers are exposed to natural hazards such as snow avalanches.

Avalanche courses aim to promote safe movement in the mountain. So far, there has been little focus on understanding the learning outcomes, reflections, and post-course applications among participants of avalanche courses.

Since the fall of 2008, 828 people have reported being caught in avalanches in Norway, resulting in 108 deaths. As of the current season (fall 2023-24), 82 people have reported being caught in avalanches, and four lives have been claimed. Northern Norways county of Troms has the highest number of incidents in Norway, affecting both tourists and Norwegians (Norges Vassdrags- og Energidirektorat, 2024).

While skiing and mountain activities are integral to our culture, this familiarity does not make us immune to the mountains' dangers. Even professionals are at risk and die in avalanches (Austin, 2023), highlighting that venturing into avalanche-prone areas even with proper knowledge and understanding can be extremely dangerous – even more so for recreational individuals and groups. As mountain travel becomes increasingly popular, comprehensive safety education is more important than ever. We advocate for more thoughtfully designed avalanche courses, believing they can help reduce the number of avalanche tragedies in the mountains.

# 1.1 Education in a wicked learning environment

The mountain serves as a "wicked" learning environment where feedback from the outcomes of actions or observations is insufficient, misleading, or missing, unlike "kind" environments where feedback clearly links actions to outcomes (Hogarth et al., 2015). Backcountry skiing requires fundamental skills to understand the factors and processes that can lead to poor decisions in the mountains. Potentially fatal outcomes, like triggering an avalanche, provide relatively rare but extreme feedback. Meanwhile, many poor decisions occur without immediate consequences. In

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such a wicked learning environment, where stakes are high, decision-making resources limited, and available feedback ambiguous; how can avalanche courses prepare backcountry recreationists to have fun in the mountains and come home to tell the story?

# 1.2 <u>Improving decision-making through dou-</u> ble-loop learning

If we want avalanche courses to be effective, it is imperative that we understand what it means to learn something, and to learn it well. Educational psychologists Alexander, Schallert, and Reynolds (2009) defined learning as "a multidimensional process that results in a relatively enduring change in a person or persons, and consequently how that person or persons will perceive the world and reciprocally respond to its affordances physically, psychologically, and socially" (Alexander et al., 2009, p. 186). Within this definition, we can distinguish between two kinds of behavioral learning – single-loop- and double-loop learning.

Single-loop learning takes place when a disruption or error is encountered and corrected without addressing the underlying guiding principles that caused the error (Argyris, 2002; Argyris & Schön., 1974). A backcountry skier encounters a challenging ascent but overcomes it by shifting her weight. The direct feedback from the mountain (steep slope) creates a single feedback-loop triggering the skier to change behavior by adapting her technique for ascending the mountain, but without changing her mindset or approach.

Double-loop learning, as described by Argyris (2002), involves questioning underlying principles before adjusting actions. In backcountry skiing, it goes beyond technique adjustment to questioning motivations. In the example above, doubleloop learning would happen if the skier not only adapted her technique for ascending the mountain but also started reflecting on why she was on such a steep slope in the first place. Ideally, by questioning the principles guiding her actions, she would realize that an alternative, less steep slope is available and change her behavior accordingly. This reflection-in-action (Hesjedal et al., 2020) leads to a questioning of her underlying values, prompting her to explore alternative approaches. Through workshops and research, she can discover techniques for finding better snow and safer routes. By engaging in reflection and double-loop learning, she can redefine her skiingapproach, challenge her assumptions, and find new strategies.

## 1.3 Purpose of the present study

The primary goal of this study was to facilitate, through a season-long avalanche course, reflective practice in the mountain by stimulating reflection on dislocatory moments among non-professional backcountry skiers. We wanted to identify in which contexts these moments happen and assess when they might additionally stimulate double-loop learning (Dassler et al., 2023). To this end, learning moments were noted and recorded and, as appropriate, classified as dislocatory moments stimulating double-loop learning.

## 1.4 Dislocatory moments

Dislocatory moments are disruptive moments that occur when individuals become aware of discrepancies between their established practices (theories-in-use) and other ideal practices, identities, views, and guiding values (espoused theories) (Argyris, 2002; Dassler et al., 2023; Hesjedal et al., 2020). These moments can mark the beginning of transformative learning, prompting critical evaluation of assumptions and deeper reflection, potentially altering one's understanding of the world (Fjellaksel et al., 2024). Such moments are usually accompanied by a feeling of cognitive and/or emotional discomfort.

Getting caught by an avalanche is a major dislocatory moment. We can assume that survival leads to reflection and potential changes in mindset about navigation and safety protocols in the mountain (Dassler et al., 2023). However, teaching through avalanche experience raises ethical concerns. Besides avalanches, what other dislocatory moments might participants in avalanche courses face while learning on the mountain?

During avalanche courses we want participants to experience what we call, "cognitive and emotional micro avalanches". These micro avalanches are less dramatic and less consequential dislocatory moments that can stimulate the same reflections as experiencing being caught by a real snow avalanche.

It is unclear if positive or negative experiences in avalanche courses drive further learning, or if fear discourages mountain exploration. We aim to investigate if skiers in avalanche terrain can recognize and report dislocatory moments associated with discomfort, potentially leading to double-loop learning. Additionally, we wanted to identify the contexts and circumstances that tend to co-occur with dislocatory moments and focus on their learning impact.

#### 2. METHOD

#### 2.1 Participants

Data were collected in 2023 from 10 participants (8 men, 2 women) aged 25 to 68, recruited through the CARE panel and direct outreach. The CARE panel is used to study decision-making and risk assessment in avalanche terrain. Participants were from Troms and Finnmark, Northern Norway, where the course was held. The participant group was a heterogenous sample representative of group composition of regular avalanche courses.

#### 2.2 Materials

The data of the study come from the participants' daily notes and reflections on a tool called the Reflectometer. A Reflectometer is a questionnaire based on the Feelometer, which evaluates the intensity of emotions during different stages of an event (Hetland, 2022; Hetland & Vittersø, 2012).

On the Reflectometer, the participants reported "key situations and decisive points for learning" along a timeline covering before, during and after a course-day (X-axis), indicating the perceived intensity of those events with peaks in relation to the Y-axis. In addition, they were asked to shortly describe the reported events. by answering six questions: (1) what happened, and (2) where the learning experience occurred. Additionally, they answered (3) What did you feel? (4) What did you think? (5) What did you do? and (6) Were there any notable consequences? Thus, the Reflectometer provided a framework capturing and analyzing short but rich descriptions of the participants' experiences, emotions, thoughts, and actions, facilitating a deeper understanding of potentially learning-relevant processes.

#### 2.3 Procedure

In spring 2023, data were collected during a season-long avalanche course. Spanning January to May, it included 11 practical days across six modules. The curriculum was inspired by Norsk Fjellforum's guidelines (Norsk Fjellsportforum, 2018) comparable to AIARE level 1 and level 2 (AIARE, n.d), and AST1, AST1+ and AST2 courses (Avalanche Canada, n.d.). Days ran from 8:30 am to 4 pm, with Reflectometer summaries provided once participants got home. The researcher instructors used feedback in these summaries to tailor course content. This directly and indirectly involved participants in shaping future content.

#### 2.4 Ethics

All participants were presented with a letter of consent informing them about the study and

rights. Data were transcribed, anonymized and stored at an encrypted server at UiT - The Arctic University of Norway.

#### 2.5 Analyses

The analysis includes daily Reflectometer reports from participants, excluding those from instructors. A qualitative thematic analysis approach was used to examine participants' opinions and reflections from the reports. This method, outlined by Braun and Clarke (2006) allowed for flexible and thorough analysis by identifying patterns (themes) in the data. The iterative process involved continuous data review (such as re-reading) and theme development (Srivastava & Hopwood, 2009). The analysis is integrated with the data presentation, combining results with their implications for interpretation.

We transcribed and analyzed 727 reported learning moments from participants' Reflectometers to identify dislocatory moments.

# 2.6 Interrater Reliability

Using thematic analysis, we identified patterns in the dislocatory moments and assessed which dislocatory moments stimulated signs of double-loop learning, and how.

To ensure interrater reliability, reduce subjectivity and improve consistency, multiple researchers independently identified dislocatory moments and discussed them in order to arrive at a clear, shared definition. The moments found were then thematically coded. The thematic categories were verified among the judges, thereby enhancing the reliability and robustness of the analysis. In the end, 90 dislocatory moments were identified.

# 3. RESULTS AND DISCUSSION

#### 3.1 Identifying dislocatory moments

A dislocatory moment, or emotional micro-avalanche, was defined by four criteria: Discrepancies between what avalanche course participants (1) thought they did, (2) knew, or (3) felt and what they actually do, know, and feel, accompanied by (4) a feeling of discomfort or uncomfortable knowledge or insight such as stress, irritation, loss of control, pressure, anxiety, embarrassment, or shock.

A thematic analysis of these moments was then conducted to understand in which situations these moments emerged.

## 3.2 Thematic analysis

The thematic analysis of the 90 dislocatory moments revealed two main themes and five subthemes, representing patterns in participants' dislocatory moments reports. Dislocatory moments were linked to themes based on working definitions, with each dislocatory "event" sometimes fitting multiple categories. For consistency, events were placed in the category with the highest associated word frequency.

#### Emotional dynamics theme

Emotional dynamics was identified as reflection that included movement and development of feelings/emotions.

#### 3.3 Analysis of dislocatory moments

The number and types of dislocatory moments varied across the modules that were introduced sequentially, over time (Table 1). A review of the table shows a decrease in dislocatory moments

Theme	Module 1-2	Module 3-4	Module 5-6	Category Total		
	n (%)	n (%)	n (%)	n (%)		
Snow	10 (26.3)	18 (47.4)	10 (26.3)	38 (100)		
Gear	7 (63.6)	4 (36.4)	-	11 (100)		
Group Dynamics	7 (43.8)	5 (31.3)	4 (25.0)	16 (100)		
Communication	7 (46.7)	1 (6.67)	7 (46.7)	15 (100)		
Emotional Dynamics	7 (70.0)	3 (30.0)	-	10 (100)		

Table 1: Frequency of 90 dislocatory moments across six modules

The two main themes, **Environment** and **Human**, provide a framework for understanding factors in avalanche courses, further divided into the subthemes of: (1) **Snow**, (2) **Gear**, (3) **Group Dynamics**, (4) **Communication** and (5) **Emotional Dynamics** (see Table 1). These subthemes encompass both dynamic (e.g., weather, relations) and static elements (e.g., terrain), reflecting the complexity of "wicked" avalanche environments. Understanding the dichotomy helps identify dislocatory moments, types of change stimulated, and potential for double-loop learning.

#### Snow theme

The Snow theme includes static (terrain) and dynamic (snowpack and weather conditions) elements used to guide nature-based risk and safety evaluations.

#### Gear theme

Gear includes physical equipment and tools, specifically in the context of backcountry skiing.

# Group dynamics theme

Group dynamics consists of several topics that influence group cohesion and performance such as interactions, peer influence, trust, leadership, roles, and hierarchy.

#### Communication theme

Communication was identified as the exchange of information, thoughts, and feelings between participants and others.

as the course progresses.

There was a consistent distribution of the Snow theme across all modules. This can be attributed to the significance of snowpack stability for avalanche safety. However, no dislocatory moments were recorded for Gear and Emotional Dynamics in Modules 5 and 6. This does not necessarily imply mastery of these topics, but it may suggest participants' increasing comfort with equipment and organization, resulting in fewer issues with packing, gear, and clothing. As participants adapted to their environment and developed coping strategies, their experiences in the course may have provoked less emotional discomfort or fewer dislocatory moments.

In terms of Communication, the consistent frequency across all modules suggests that it remains a continual focus and challenge. Similarly, Group Dynamics require ongoing effort, despite a decrease in dislocatory moments. Factors contributing to this reduction may include participants' increasing emotional resilience and improved teamwork as the course progresses. Initially, the intensity and novelty of experiences may have led to more dislocatory moments and emotional arousal. However, as participants adapted, events became more predictable, resulting in fewer dislocatory moments. This decrease may also be attributed to the group's growing teamwork and cohesion, which enhances communication and reduces dislocatory moments. As participants become more familiar with each other and their roles, conflicts and emotional tensions may decrease. Increased confidence in expressing themselves, rather than carrying frustration, may foster improved Group Dynamics.

The frequency of dislocatory moments could vary depending on the instructors' roles. They were meant to switch from observer to mentors, intervening less, in Modules 5 and 6. More dislocatory moments may be reported when instructors are actively teaching and pointing them out. Changing roles can shift participants' focus, so even though fewer dislocatory moments were reported towards the end, it does not necessarily mean that was the case. Compared to a major dislocatory moment, such as being caught by avalanche, this suggests that learners typically require external intervention from an instructor or a touring friend to become aware of discrepancies. This highlights the main difference between a "real avalanche" and a "micro avalanche" encountered during avalanche courses, where the instructor must take on the role of an avalanche, actively engaging and assisting students in recognizing when they are unaware of their actions.

Each categorized dislocatory moment was subsequently analyzed on three levels based on our definition of double-loop learning. The overall number and distribution of dislocatory moments indicate a significant portion where there is a discrepancy in experience across behavior, thinking, and feeling, with the largest proportion of change stimulated in participants' thinking or understanding and reflection.

In the Group Dynamics theme, an example of analysis was when a participant, who typically assumes a leadership role, felt conflicted when no

one else stepped up to lead. This conflict arose from uncertainty about the group's expectations, leading the participant to hold back. This hesitation revealed a discrepancy between their usual behavior and the ambiguity of the new situation. The participant's subsequent reflection, questioning of their own decisions, and consideration of taking on a leadership role next time indicate deeper introspection and potential for double-loop learning in adjusting their approach.

# 3.4 Signs of stimulated double-loop learning

How can we identify potentially stimulated double-loop learning through dislocatory moments? Out of 90 dislocatory moments, 52 (Table 2). showed signs of stimulating double-loop learning, through explicit or indicated reflection on one's actions, and the potentially stated possible consequence of the reflection.

Each dislocatory moment that showed some indication of double-loop learning involved changes in thinking, or understanding, and reflection. There were no instances where double-loop learning was stimulated by dislocatory moments characterized by discrepancy in doing or feeling, alone. This underscores the role of thinking, understanding, and reflection in fostering double-loop learning (Hesjedal et al., 2020). Snow theme exhibited the highest occurrence of signs of stimulated double-loop learning, with 24 (Table 2) out of 38 (cf. Table 1) dislocatory moments. However, Human subthemes were collectively significant.

When participants become aware of their own practice and experience shifts in understanding or thinking, and reflection, it may indicate revising mental models and understanding of the world.

Double-loop?	Snow		Gear		Group Dynamics		Communication		Emotional Dynamics		Total	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
A	-	-	-	-	-	1	-	1	-	1	-	3
В	12	9	6	3	4	3	7	2	1	1	30	18
C	-	-	-	-	-	-	-	-	-	1	-	1
A and B	8	4	2	-	3	5	2	1	2	2	17	12
A and C	-	-	-	-	-	-	-	-	-	-	-	-
B and C	3	1	-	-	-	-	-	1	-	1	3	3
All	1	-	-	-	-	-	-	1	1	-	2	1
Total	24	14	8	3	7	9	9	6	4	6	52	38

**Table 2:** Distribution of signs of stimulated double-loop learning, Yes/No. Dislocatory moment stimulated change in A: doing, B: thinking, or understanding and reflection, C: feeling.

Therefore, we argue that altered understanding of the world through reflection and insight may be crucial prerequisite for changing action, which is particularly important in the context of safe movement in the mountains. This emphasizes the importance of reflective practice for double-loop learning (Hesjedal et al., 2020). Dislocatory moments that stimulate change in thinking, understanding, and/or reflection can prompt this.

## 3.5 Implications and future directions

From 727 key learning moments, we identified 90 dislocatory moments. Among these, 52 showed signs of double-loop learning when the events stimulated changes in thinking or understanding and reflection. This indicated that double-loop learning can be stimulated through dislocatory moments. Thematic analysis revealed two main themes and five subthemes. Besides avalanches being a major dislocatory moment, the occurrences were evenly distributed between environmental and human factors, highlighting the importance of the course's comprehensive approach to avalanche assessment when learning on the mountain.

Double-loop learning requires reflection on the assumption and biases that shape one's thinking (Argyris, 2002; Argyris & Schon, 1974; Hesjedal et al., 2020). Our study supports Hesjedal et al.'s (2020) findings, where participants developed a meta-perspective through reflection on their practices, values, and beliefs. Unlike Hesjedal et al.'s (2020) study, which found that double-loop learning results from a cumulative effect of dislocatory moments, we discovered that individual dislocatory moments could also show signs of double-loop learning, potentially changing participants' mountain practices in the long term.

Participants' awareness of discrepancies between their practices and others' can prompt reflection, potentially leading to double-loop learning. While dislocatory moments show signs of stimulating double-loop learning, we shouldn't overlook that double-loop learning can occur in non-dislocatory moments. We should also note that our definition accounts for expressed feelings of discomfort and may exclude unreported instances of discomfort.

Imagine revolutionizing avalanche courses by harnessing the power of dislocatory moments to spark reflection and double-loop learning, leading to changed behavior and reflective practice among backcountry skiers. Our initial research with ten participants over several months showed this potential. Now, we envision a more focused, dynamic approach.

Future studies should target several regular courses with typical groups of participants. Comparing their Reflectometer reports with those from this study can identify similarities in key learning moments, dislocatory moments, and their contribution to double-loop learning through reflection for both instructors and participants.

This study revealed fewer dislocatory moments over time, likely due to reduced emotional discomfort and a more comfortable group dynamic. We recommend studying groups with some prior familiarity or starting a course with trust-building activities to encourage open communication, maximizing learning potential.

# 3.6 Limitations

The Reflectometer is a tool used to gain insights into learning experiences, but it does not capture the full spectrum. Fjellaksel et al. (2024), describe it as indicative rather than exhaustive, offering valuable but limited insights.

Some participants submitted their reports late, which may have led to incomplete or inaccurate recollections. Delayed reporting can distort memories, affecting data accuracy. However, participants' recollections may be more relevant to learning than precise details.

On the one hand asking participants directly about discomfort and their feelings is recommended, as some reported thoughts instead of feelings, excluding potentially uncomfortable events from analysis. On the other hand, asking directly about uncomfortable feelings may prime participants to actively look for these, which might introduce further bias into the data set.

Social factors, such as group norms and concerns about instructors' responses, can influence Reflectometer reports. Participants might avoid reporting incidents due to discomfort over instructors' access to the data. Interpreting Reflectometer data with instructors' field notes and other complementary data is recommended for validation.

#### 4. CONCLUSION

In the world of backcountry-skiing safety is crucial. Simply attending an avalanche course does not guarantee safe practice. A desirable goal for avalanche education is to teach people to stop, assess, think, feel, and evaluate the conditions and their own behavior, especially when (social or ecological) conditions are changing on the mountain. Participants in our avalanche course engaged in reflective practice, paying more attention to what they were doing, why they were doing it and whether they should change anything. The

Reflectometer supported and boosted this reflective practice, creating heightened introspection among participants, insight for instructors, and signs of stimulated double-loop learning.

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