LIFE-LONG LEARNING FOR SAFE MOUNTAIN FUN: TRANSFORMING BACK-COUNTRY SKIERS´ PRACTICES THROUGH STIMULATING DOUBLE-LOOP LEARNING AT AVALANCHE COURSES

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ABSTRACT: When skiing in avalanche terrain in the backcountry, bliss and happiness are always close to potential injury and even death. Safety in the snowy mountains therefore requires knowledge about avalanche danger. Avalanche education is a means to help people learn how to safely manage those dangers. We here argue that reflective double-loop learning is key for facilitating efficient and long-lasting learning. When dealing with an important problem to be solved, double-loop learning distinguishes itself from single-loop learning by including a feedback loop for reconsidering and changing one's preconceptions or mental model around the problem. Double-loop learning is triggered by dislocatory moments. These occur when one becomes aware of discrepancies between one's established practice and alternate practices, views, identities, or guiding values. Deep learning occurs through thoughtful reflection on such moments. When reflection is invited in a structured way, double-loop learning can also stimulate more lasting interest in learning beyond any single avalanche course that is necessarily limited in time, space, current conditions, and the characteristics of the learning group itself.

In our innovative avalanche course, participants' learning was monitored throughout an entire ski season (11 days of praxis), using reflective practice to foster lifelong learning for safe mountain fun. Participants were co-designers, with their experiences and reflections forming course content. Feedback, self-assessments, observations, interviews, and skill surveys were used to adjust learning processes, evaluate progress towards course objectives, and assess overall course efficacy. We will present this novel approach to studying avalanche education and our findings.

KEYWORDS: Avalanche education, double-loop learning, wicked learning environment, backcountry skiing, reflective learning

HIGHLIGHTS

Double-loop learning stimulated by dislocatory moments:

- Contributes to observable change of practices for avalanche course participants,
- creates interest and provides participants with resources to continue learning after the course,
- can be adopted in teaching practice as a method that is compatible with a stop – assess – re-evaluate procedure, and
- provides avalanche course instructors with resources for own learning and development.

1. INTRODUCTION

Avalanche condition assessment is a complex task, pregnant with uncertainties and ambiguities even for experts (Landrø et al., 2020a; 2020b). Little focus has been put on how we teach backcountry skiers how to address and relate to the inherent uncertainties when making decisions in such a "wicked learning environment" (Hogarth, 2015) that snowy mountains are.

Avalanche courses in Norway are usually 1 – 3 days courses focusing on how to use avalanche gear, companion rescue and how to travel safely using the terrain to avoid avalanches. Such a course also gets one started on snow characteristics and the human aspects. What can be taught and learned at these courses is usually ambitious in scope (and therefore challenging to learn deeply) and dependent on the current conditions such as predominating avalanche conditions and learner group composition. Given the complexity of avalanche condition assessment, learning and teaching all the aspects of decision making in avalanche terrain in a 1 – 3 day course is not feasible, yet it is commonly offered and taken, and is more affordable, in terms of both time and expense, than longer courses.

Being practicing avalanche instructors, we reasoned that learning the skill of how to stop, assess socio-ecological conditions, and then reevaluate own travel plans if necessary is an important complement to the teaching of extensive catalogs of learning objectives.

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Also, spending more time on both is foundational for truly transformational learning. This more reflective approach, teaching learners important knowledge and practice together with the knowledge and skills for how to reflect on what they know and do in order to evaluate whether they are adequate to address the problem at hand (Argyris & Schön, 1974; Hesjedal, 2020; Schön, 1987, 2017) is central to our work.

Alexander et al. (2009) describes 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." (p. 186). Thus, learning is fundamentally rooted in a systemic, dynamic, and interactive connection between the learner, the type of learning and its subject matter. This connection is ecologically placed in a specific context and period, and evolves over time. Learning is framed within four dimensions, focusing on the *What*, the *Where*, the *Who* and *When* of learning. Alexander et al. (2009) emphasizes that change in how a person "perceives the world" is a pre-condition to reacting to this changed perception. In other words, if learning does not lead to me seeing or understanding something new or different, why should my behavior change to something new or different?

Thus, in this paper we will focus on how we can facilitate certain types of learning at avalanche courses that can change our perception of the world, or a problem we want to solve in more informed and adaptive ways; we do this through ***double-loop learning***. Our assumption here is that in addition to weather, snow, terrain and people skills, learning to make good decisions in the mountains ***requires a self-reflective element*** that contributes to us being able to actually change what we are doing based on the new knowledge we acquire. It is important to evaluate one's own motivations, goals, knowledge and ways of understanding what it requires to travel safely in the mountains. Further, this can inform an understanding of why it might be a good thing to not only change, but improve, one´s practices *in situ*.

Double-loop learning helps people acquire and integrate new information and develop new skills, to question and revise familiar and perhaps biased ways of thinking, feeling, and acting by providing an additional feedback loop (Argyris & Schön, 1974; Hesjedal, 2020; Schön, 1987, 2017). Such *reflection-in-action* (Schön, 1987), that is, double-loop learning and the revision of one's mental models, can be triggered by dislocatory moments.

Dislocatory or disruptive moments (we will use these terms interchangeably throughout the text) are moments that occur when one becomes aware of discrepancies between one's established practices and other practices, views, identities, or guiding values. Being caught by and surviving an avalanche is probably the archetypical dislocatory moment. It is assumed to be an event of such a magnitude that it will lead to reflection on, and change of, one's own practices of traveling in and around avalanche terrain. For many of us it might have been the decisive moment that sparked our interest in learning more about avalanches and how to avoid them in the backcountry.

Observing situations that trigger dislocatory moments may enable us to identify when and assess whether double-loop learning happens during an avalanche course. To explore that, we designed a season-long avalanche course to explore how to facilitate double-loop learning through dislocatory moments, in ways that would provide participants with opportunities to reflect on (and hopefully improve) their own practices in action.

2. SAMPLING AND COURSE ORGANIZATION

2.1 Sampling and recruitment

Course participants were recruited through the CARE panel (2023), a longitudinal study of what effects people´s behavior in the backcountry. Prior to recruitment, we made practical considerations such as the participants physically being able to participate in the course and limited our area of recruitment to the region of Troms and Finnmark in Northern Norway. All received information about the content of the course and when they needed to participate physically prior to their decision to opt in. In total 29 participants opted in, 22 through the CARE panel, and 7 by getting in touch with us directly. We sought participants who self-reported having low to average skills in assessing avalanche danger, and average skiing skills for skiing in avalanche terrain -- both release and trigger areas. Of the 16 applicants who received an offer to partake in the course, 12 confirmed their participation, out of which 2 dropped out prior to the first course day for practical reasons, leaving us with a sample size of 10 participants (8 men and 2 women). Even though great care was taken during recruitment in vetting each participant individually, it soon became very clear that skill levels and answers from the survey data pertaining to formal avalanche education did not correspond with reality, leaving us with a more mixed group than was initially anticipated, both in terms of skill levels and prior avalanche education.

2.2 Course organization and ethics

The course was organized in the form of a modular design consisting of 11 praxis days organized into six modules that were spread out over the whole skiing season. The first module took place in January, two in February and one module each in March, April and

May. The January module consisted of getting to know each other and a baseline tour where we observed the group´s behavior when traveling in and around avalanche terrain. The other modules consisted of two praxis days. One whole day was spent indoors due to a polar low pressure. This gave us the possibility to focus on theory of snowpack and people dynamics and different approaches toward trip planning and traveling in avalanche terrain. The first five days of the course followed the curriculum for basic and advanced avalanche courses of the Norwegian Mountain Forum (Norsk Fjellsportforum, 2022), a national non-governmental organization that among other things certifies avalanche instructors and creates standardized course curricula for avalanche courses.

The content of each module was informed by feedback from the participants who thus became co-designers of the course. This meant that the roles of the two researchers who also were instructors changed from being mainly instructors, that is, teaching people what to do and how to do it, to being mentors who observed and guided the learning process.

We chose a knowledge-based analytic approach toward avalanche conditions assessment that was inspired by Kronthaler´s (2019) Systematic Snow-Cover Diagnosis where weak layers in the snowpack are identified, analyzed and judged for their likelihood of leading to avalanches. This approach was continually contrasted, complemented and taught along a more test-based approach that focused on stressing the snowpack and testing for instabilities through both formal (in)stability tests such as the Compression Test (CT), Extended Column Test (ECT), Propagation Saw Test (PST) and Rutschblock Test, as well as quicker-to-execute informal tests such as the Burp Test, Handshear tests, and various tests where ski poles where used to probe the snow and determine weak layers.

A typical course day would last from 8:30 am to 4 pm for the course participants. That included driving to and from the mountain, pre-trip meetings, ski tour with focus on the different dimensions of travel in and around avalanche terrain such as use of terrain, snowpack assessment, companion rescue, and human aspects of making decisions in the mountains. It also contained a debrief at the parking lot after each course day.

For the researchers and instructors, a typical day would usually start with a safety meeting prior to participant arrival, then the same as the participants´ days for as long as the group was together. The researchers would then write down a first rough draft of field notes immediately after the debrief. Extended field notes were taken each day and written down within 24 hours after a course day. For the modules with two successive course days this usually meant 16-hour+ workdays for the researchers, writing field notes late into the night to avoid mixing it up with the observations made the next day.

After each course day participants filled out reflectometers (see section 2.4), questionnaires after each module. They also filled out a skill survey (AviLog) based on Landrø et al. (2020a, b) after the baseline tour (module 1) and after what would correspond to an advanced avalanche course halfway through the course (module 3).

An adequate HSE procedure, including doing extended risk assessments for each course module and training participants in risk mitigation and companion rescue was developed. Off-piste travel is considered a high-risk activity. Thus, a legal assessment was required to determine who is legally responsible in the case of an accident, or more importantly who is paying the bills. The study was approved by the Norwegian Centre for Research Data (GDPR) and by the institutional review board at the Department of Psychology at UiT.

2.3 Study design: qualitative and quantitative methods

The study originally had a purely ethnographic design, using the method of participant observation to capture how the course participants´ socio-ecological embeddedness (Løland & Hällgren, 2022) influences the process of learning, and whether double-loop learning could be facilitated through dislocatory moments that provided participants with the resources to reflect on and change their own practices. Two researchers also qualified as avalanche course instructors served as participant observers while teaching the course. Known to the course participants, a third researcher was placed as an observer within the participant group. This provided us with different perspectives for observation and analysis and the possibility to observe what participants were doing and situations that are more difficult to reconstruct retrospectively through interviews (Jerolmack & Khan, 2014). The researchers participating actively allowed for deeper relationships with the participants and co-designers and better data (Gold, 1958). The risk of becoming too close to the participants was minimized through questioning preconceptions and understandings of the researchers' respective roles, and frequently asking "what's going on here?" (Spradley, 1980). Another researcher who was not partaking in the field work continuously asked "naïve" and critical questions and commented on the transcribed field-notes to challenge our interpretations by asking for alternative explanations of what was going on.

Researcher observations were complemented by the reflectometers (participant observations) as well as post-module questionnaires and skill surveys from participants. After the course, two focus groups were also conducted. This triangulation of methods and data sources allowed for a multi-perspectival and

comprehensive understanding (Patton, 1999) of the learning happening during the course including through dislocatory moments. The skill surveys (AviLogs) were used to check for change in what kind of weather, snow and human factors participants are tracking and are conscious of when compared with instructors. Post-module surveys were taken by participants to evaluate their own learning progress and needs for further development. Additionally, they served as a formalized way for the participants to give feedback as co-designers that was complementary to oral feedback during course days and debrief.

2.4 The reflectometer: Observation and reflection

Based on the *Feelometer*, a tool to visually measure and quantify the intensity of feelings during an activity (Hetland, 2022; Hetland and Vittersø, 2012, p. 163) we developed an adapted version to let participants report dislocatory moments in an easy and efficient way. We called it the *Reflectometer.* On the reflectometer participants were asked to draw the intensity of how they experienced what we described to them as "key situations and decisive points for learning". Additionally, we asked the participants to shortly describe these moments by answering six questions: *What happened? When/where did it happen? What did you feel? What did you think? What did you do? Were there any notable consequences?* The reflectometers effectively worked as fieldnotes *fast and light*. One of the immediate advantages was that we were now able to compare our fieldnotes to what was showing up in the reflectometers. In many cases the dislocatory moments observed by the researchers corresponded to what the course participants reported as decisive learning situations. Thus, indicating that a learning experience was going on. This, in turn, increased the trustworthiness of the researchers´ observations. Additionally, the reflectometers provided richer data of the participants´ experience; what happened, what they thought and felt.

2.5 Analysis

There were five sets of data: (1)The field notes based on observations by the researchers; two from the instructors´ perspective, one from the participants´ perspective, (2) The reflectometers filled out by all the participants and two of the researchers; one who was participant observer as an instructor, and one who was participant observer as a participant, (3) The questionnaires participants filled out after each module and prior to the planning of the next module, (4) Data from AviLog surveys, and (5) Focus group data.

Dislocatory moments were described and thematically analyzed. New categories were defined where several dislocatory moments overlapped thematically. Three prominent themes of dislocatory moments leading to double-loop learning emerged from the initial analysis: Environment as disruption, humans as disruption and teaching as disruption.

3. DISRUPTIVE MOMENTS: FINDINGS AND INTERPRETATION

Initial analysis of data from field notes, reflectometers and focus groups shows at least 69 potential dislocatory moments of oscillating intensity throughout the course. Some were shared between participants and instructors, some were only shared within the participant or instructor group, and some were highly individual to either participants or instructors. We will here present some of the major disruptive moments that showed up in the data pertaining to the three themes emerging from our analysis.

3.1 Environment as disruption

Numerous dislocatory moments related to the ecological setting and environmental elements. In this context, we will focus on avalanche terrain and snow as examples.

Snow

Seeing layering and crack propagation in the snow and experiencing different snow layers slide served as dislocatory moments unsettling and redefining the participants´ mental maps of what was going on when weak layers were present in the snowpack. Among other things leading to both individual reflections and discussions between participants and between participants and instructors, "under which conditions it is a good practice to check or test the snow for instabilities?". This was a change in reflective practice in contrast to earlier established practice. The results indicate that stimulation of double-loop learning was different for each participant throughout the modules. This was due to a varying observed and reported change in the participants´ prior assumptions. At the end of the course some participants struggled to identify weak layers and some participants had gained higher self-reported and observable competence in snowpack analysis. This was demonstrated when a participant discovered an additional weak layer the instructor had not noticed using the Extended Column Test (ECT), which in turn triggered a discussion of which tests are most adequate for identifying and assessing weak layers in the snow.

Avalanche terrain

Participants are familiar with the concept of avalanche terrain, but do not apply this knowledge consistently in practice, leading to inconsistencies between what they think, say and intend to do and what they *actually* do. "All of us are behaving like sheep", was exclaimed by a participant who pointed out that

the group was following the leader blindly into avalanche terrain even though they previously had agreed to avoid all avalanche terrain under current conditions. Dislocatory moments of similar nature occurred repeatedly in modules 1 to 4. Interestingly, participants reported fewer instances of such dislocatory moments in modules 5 and 6 even though they were still observed by the researchers. In many instances a more reflected approach was observed by the researchers; participants checking in with the group and engaging in thorough discussions on avalanche terrain before entering such areas. There were still situations when the group did not discuss going into avalanche terrain, however. Pointing out these situations to the participants usually created disruptions that led to reflection and group discussion. This did not mean that everyone in the group agreed that it was problematic entering avalanche terrain under current conditions. In the discussions and group reflections, the theme of "but it is safe today", and "the snow *felt* safe", meaning that it was not an issue being in avalanche terrain under current conditions, was usually one of the first responses from some of the participants in the groups. In several instances, other participants pointed out that they found it quite uncomfortable having realized that "I have been on that mountain probably 30 times, and I don't think I have ever made a single assessment of the conditions."

In summary, we observed a positive change in reflective practice with reference to individual and group behavior before entering avalanche terrain compared to our baseline tour. Nevertheless, our results also indicate that it takes considerable time to reconsider and change one's preconceptions or mental models of the problem at hand and implement new knowledge through change in practice.

3.2 Humans as disruption

Many human-related dislocatory moments were observed and reported by both researchers and participants. Particularly one situation resonated strongly with many of the participants. In module 3 we facilitated a discussion with someone who had survived an avalanche incident. A lack of motivational clarification within the group played a vital role in that incident. The discussion evolved around that issue and what motivates us as skiers. One participant asserted how the conversation made him "reflect upon my own willingness to take risks, and for the future I want to ensure that I clarify a common understanding of risk before touring with a group". This indicates that the conversation created a realization of the importance of communication, and that a group is built as a collective of individuals. The discussion with the avalanche survivor served as a significant dislocatory moment that resulted in course participants reflecting on the importance of group dynamics in an activity that very often is built on a foundation of it being experienced in a group. Another participant stated that "being put in a situation where we were ´forced´ to reflect, created an awareness of my own thought processes, why I feel fear of missing out and what my motivations actually are". This statement indicates that by facilitating a conversation that creates room for and invites reflexivity, it can create a spark that triggers discovery and/or revision of one's mental models through double-loop learning. The participants´ responses clearly display how they reconsider and change their own conceptions of elements connected to motivational aspects and other factors that contribute to the relational dynamics of ski touring.

Facilitating discussions that invite participants to reflect on how their own motivation affects others and themselves can disrupt their pre-established practices. Our findings indicate that such discussions can generate a feeling of high learning intensity and that a reflective and inquiry-based approach (Lipman, 2003) toward avalanche education can not only contribute to skiers reflecting on their own practices but can also be facilitated by any instructor at any avalanche course as long as participants are willing to engage with the topic and the facilitator.

In summary, a facilitation of reflection – through a discussion with a survivor of an avalanche incident – made our course participants reflect upon individual thought processes and motivational factors. Our results indicate that individual participant reflexivity, or self-reflexivity, also prolongs towards reflecting on the relational dynamics (in all its complexity) by reconsidering their own attitudes and practices making them ask questions such as "Why do I want what I want?", "Who do I want, what I want, with?", and "How do we talk about what we want?".

3.3 Unexpected (reflexive) turns: Teaching practice as disruption

Turn 1: Checklists and decision-making tools as disruption.

Using checklists or decision-making aids in the form of little plastic cards (Landrø et al., 2020a), one can bring along on a backcountry ski tour really sounds like a good idea. They provide the ski tourer with a structured decision-making tool that tells you what to look for and helps you evaluate your choices. Even though course participants were introduced to the Norwegian avalanche card as a decision-making aid, the tool was not used by participants during the course. This created a much-discussed dislocatory moment for the instructors. One of them recording in the field notes "I have so many thoughts about the avalanche card, which could be an incredibly useful tool, but no one bothers to use it. […] Heck, I never use it when I'm on a tour." This impression was a shared experience amongst all the researchers who were out in the field. One of them, during a debrief,

declared that “It's unnatural to fumble out [the avalanche card], it's artificial, it often disrupts the flow and it's very static. In 19 out of 20 cases, the card just tells me what I already know. It's an intervention in a sense-making process. Something that ruins the flow of a good day in the mountains with friends.”

The useful but unused avalanche card created a dislocatory moment and an additional feedback loop for both instructors that prompted a reassessment of the use of such tools in avalanche courses. It led to the instructors pondering the question whether it is “smarter to use the avalanche card as a tool to pause more often, to ask important questions, to create disruptive moments”, indicating revision of the instructors´ mental model through double-loop learning.

Turn 2: Learners teaching the teachers.

Since the season-long course was different from regular avalanche courses systematically and structurally, inviting participant-feedback (debriefs, reflectometers, surveys) and designating participants as co-designers, the instructors also learned during the course. One significant dislocatory moment that triggered instructor learning occurred when a small, above-30 degrees steep slope that had formed wind slabs slid after the instructor and two other participants had crossed the slope. The last two participants observed this happening. Once they managed to catch up to the rest of the group on top of the slope the instructor just kept on going without the participants being able to report what they had seen. The weather conditions were not inviting for long discussion. This led to the rest of the group, including the instructor, not being aware of the unstable slope (which was later skied down). Until the end of the trip, nobody in the group (except for the two participants who observed the earlier slope slide) was aware of the potentially unstable snow. It was first during the debrief that this was mentioned. But even then, it was difficult for the participants to present and understand the significance of the event. Even the instructor did not properly catch its significance until both participants described the same situation in their reflectometers later that day, writing, among other things, that this “was a section that we should have discussed afterwards”.

We were in fact exposing the group to a potentially unstable slope risking them to be harmed. We did this even though two of the group members had the information necessary to do a more thorough assessment or choose a different route down the mountain. However, the information was not shared amongst all the members of the group. Reviewing the reflectometers triggered a dislocatory moment in the leading instructor to asking questions such as “How could I have missed this? Why were the participants not able to share this important information with the rest of the group? How much power do I have as the instructor in signaling what is important information and what not?”. This extra thinking-loop effectively had the instructor rethink his approach toward teaching and facilitating information-sharing and question-inviting behavior in avalanche courses. Subsequently, it triggered so much discomfort and unrest for the instructor that he had to address it the next course day, prior to the planned trip. This was an archetypical situation where the dynamic relation between the environment (snow, weather, steepness of terrain and geographic location), the group, and its individuals, created a dangerous situation that could have had potentially harmful consequences for all group members, even affecting the possibility to continue the research project. It provided a great learning opportunity for the group to reflect on whether it was the individual, the social or the ecological aspects or the complex relation between them that created this potentially perfect storm. This was experienced as a constructive process and great relief for the two participants that reported the situation in their reflectometers and who had above average negative experiences related to that they did not manage to share the information or stop the group when riding down the steep slope. “I felt stressed. I did nothing,” wrote one.

Without explicit feedback and reflection-inviting structures in place, the whole situation and thus a great opportunity to rethink one´s own practices, would have been missed. The two participants experiencing this uncomfortable dislocatory moment explicitly wanted to have more focus on communicating danger signs more effectively in the future. For at least one of the participants this became an recurring theme, indicating clear signs of rethinking one’s own preconceptions and thus double-loop learning. In the instructor and researcher team, this led to a discussion of the importance of skills we usually do not teach in avalanche courses. Skills such as courage (to say stop and share important, risky information) or how to communicate in a constructive and non-awkward way with peers.

3.4 Results from AviLog

Participants filled out a log after the baseline tour in January and after module 3 in March. At this point participants were halfway through the season long course and at a stage that is comparable to having finished a level 2 avalanche course in Norway, with the major difference that it was the same group, and the course modules were progressively building on each other. We found that (1) there was a significant change in participants reporting putting higher effort into assessing conditions, and (2) participants rated communication, participation and agreement in the group higher with course progression. These findings may support our observation that participants im-

proved on making group decisions by sharing information, reflecting on and deliberating that information, and making shared decisions. It could also indicate that they experienced the effort connected with communicating efficiently to be lower since they had become a community of inquiry (Lipman, 2003). As substantiated by our observations, reports of higher effort in assessing conditions could mean a high learning intensity and that participants had to process a lot of new information struggling to apply in the field.

4. DISCUSSION AND IMPLICATIONS FOR AVALANCHE EDUCATION

Our findings show that there are many sources for disruption that can initiate reflective learning processes and prolong interest. In our course, the environment (the snow, the terrain, the weather) as well as people (the learner him/herself, the instructor, and others in the group) could trigger moments of dislocation with the potential to disrupt practices and stimulate double-loop learning. While we find empirical evidence that disruptive moments contributed to double-loop learning, we also find that such moments alone usually are not enough. What provided the participants with the resources, opportunities and obligations to reflect on their own practices was the invitation to do so following a dislocatory moment, either shortly afterwards, at the end of a course day (debrief), or after a course day using a reflectometer.

Toward the end of the course some of the participants were still only doing a fraction of the things and assessments we would like for them to do, but as our observations and AviLogs show, they progressed immensely, spending more time assessing environmental and human aspects of decision making while their group communication improved.

We find that avalanche courses can be transformed into a rewarding process of learning through experience and reflection so that participants are able to integrate both comfortable and uncomfortable knowledge about snow- and people dynamics into their own practices.

As avalanche educators we can facilitate double-loop learning stimulated by dislocatory moments that:

- Contributes to observable change of practices for avalanche course participants,
- creates interest and provides participants with resources to continue learning after the course,
- can practically be adopted as teaching method that is compatible with a stop – assess – re-evaluate procedure, and
- provides avalanche course instructors with resources for own learning and development.

For our course participants and ourselves, we want to avoid the ultimate disruption in our skiing lives, the worst of dislocatory moments of being caught in an avalanche. We can increase that likelihood by actively using dislocatory moments and double-loop learning in the courses we teach.

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