

## REFLECTOMETER: A NOVEL TOOL TO BOOST LEARNING IN AVALANCHE COURSES

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**ABSTRACT:** Every avalanche educator wishes for course participants to learn. But do we really know when learning occurs for participants? What could we as instructors learn from knowing what participants experience as, often invisible, key learning moments – not just during the learning task itself, but also in preparation for and after the task? In this paper, we introduce a novel tool, the Reflectometer. It is designed to facilitate self-reflection for participants and enable avalanche instructors to learn from course participants about disruptive moments from teaching that turn into learning moments in a structured and immediate manner. Following each day of the avalanche course, we distributed the Reflectometer to participants providing them with a reflective task related to that day's content. Subsequently, participants were tasked with completing their reflections by the end of the evening, either electronically or by paper. Upon receiving the completed Reflectometer, instructors gained valuable insights into the participants' key learning moments. The participants reported learning from reflection and the instructors learned from what participants experienced as key learning moments. One major limitation may be the effort required using the Reflectometer in an avalanche course setting and interpreting the results. However, in our study the benefit of using the Reflectometer outweighed the effort needed. Furthermore, we have since developed a user-friendly web-based Reflectometer tailored specifically to stimulating reflection about course participants' own touring practices.

**KEYWORDS:** Avalanche education, two-way learning, reflective practice, reflection-based learning, avalanche courses

### IMPLICATIONS FOR AVALANCHE EDUCATION



**Enhancing course participant reflection:** The Reflectometer serves as a flexible tool that encourages course participants to engage in self-reflection about their learning processes and ski touring practices.



**Supporting instructor development:** The tool also benefits instructors by providing insights into course participants' learning processes, thereby facilitating opportunities for instructors to learn from their students.



**Responsive teaching practices:** By integrating insights gained from the Reflectometer, instructors can promptly respond, adjust and tailor their teaching strategies to support and enhance reflection-based learning.

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## 1. INTRODUCTION

Developing a reflective practice is considered essential in areas of life where theory and practice need to merge and that involve learning to make decisions under uncertainty, where stakes are high and the environmental and human context dynamic and continuously changing (Argyris and Schön, 1974; Schön, 2017). Such is the case in avalanche education and when learning how to make safe decisions in hazardous winter mountains (Fisher et al., 2022; Stewart-Patterson and Patterson, 2014).

### 1.1 The importance of reflective practice

Reflective practice has been shown to enhance self-awareness, personal knowledge, and the evaluation of actions (Morgan, 2009). Reflection on experiences is essential for experiential learning (Kolb, 1984) as well as for transformative learning (Mezirow, 1978) and wherever the quality and authenticity of learning experiences is limited by our humanness, time and space (Alexander et al., 2009), as well as the number of learning moments one encounters (Dassler et al., 2024; Landrø et al., 2022).

Our experiences influence what we do. For example, how experiencing and surviving an avalanche affects a person's future actions will depend on how that person remembers the experience and understands and reflects on that. For example,

- 1) if they, on the one hand, think that they were just unlucky and that it was not their fault, they might conclude, that they could have done nothing about it. Whether they will continue to travel in potentially hazardous terrain in winter mountains will thus depend on the acceptance of the role luck plays in their safety and their acknowledgment that it is beyond their control.
- 2) On the other hand, the person reflecting on the experience, and what actions and judgements that may have led to triggering the avalanche, might realize that the avalanche was a consequence of the complex interplay between environmental conditions and their own actions. They were at the wrong place at the wrong time, and the avalanche incident could have been prevented by either avoiding the avalanche problem and/or steering clear of avalanche terrain entirely under current conditions. If that is their take home message, then this person may try to learn more about understanding and managing avalanche risk, especially if they want to continue doing what they love; blissfully skiing in untamed winter mountains.

These examples illustrate that for experience-based learning, it is important to have experiences, but it is not solely the feedback from the factual experience

itself that affects our future actions. What is decisive is how we remember our experiences and how this understanding of our experiences thus influences future actions. How we remember and understand experiences can, in turn, be affected by if and how we reflect on them.

### 1.2 The importance of feedback for learning

To be able to reflect on our experiences, we need feedback. Feedback is an important part of creating the constructive alignment to improve learning (Biggs, 2011). This is true for avalanche course participants' learning experiences. However, instructors can also learn from their teaching experiences by reflecting on their own practices. For that to happen, instructors need feedback on the effectiveness of their teaching. Such feedback can come in various ways, for example, through course evaluations or by testing course participants. But learning takes time – especially in fields where theory and practice are merged so intrinsically such as avalanche education. Testing theoretical skills may not be enough to see whether course participants can use their newly acquired knowledge in their own backcountry touring practices. But the testing of applied practical skills may be even more challenging. For instance, guidelines for level 1 avalanche courses in Norway command that “There is no assessment of the participants after the course.” (Norsk Fjellsportforum, 2018, p. 4). There can be many reasons why evaluations and testing course participants is difficult or impractical.

So, do you know when learning happens for your course participants? And how can you, the instructor, be sure course participants have truly learned during the course? More importantly, how can you help participants learn *and use* more of what you teach?

### 1.3 A tool for identifying what happens, when learning happens

To improve our teaching practices our team of researchers, backcountry skiers and avalanche instructors embarked on a quest to capture *when* learning was happening for participants during a course, and *what* was happening in these learning moments. We wanted to identify significant learning moments; we call them Key Learning Moments (KLMs). KLMs are intense experiences the course participants remember and report from before, during or after a learning session, for example, shortly after a course day. When capturing KLMs, we were interested in how intensely they were experienced, what happened, when and where it happened, what course participants thought, felt, and did, and whether or not it led to any notable consequences.



Figure 1: Showing an example of the Reflectometer including the six questions for each Key Learning Moment, how intense these KLMs were experienced (y-axis) and when they happened in relation to a learning session (x-axis).

To derive a holistic understanding of what was going on during participants' KLMs, we developed the Reflectometer (see Figure 1). A tool to capture participant learning and stimulate participant reflection at the same time. As a bonus you, the instructor, get feedback on the participants' learning experiences when using the tool, which is food for thought and reflection on how to improve your own teaching.

## 2. MATERIAL AND METHODS

### 2.1 *The Reflectometer: A novel tool for two-way learning*

The Reflectometer is based on the Feelometer, a tool originally used to visually measure and quantify the intensity of emotions (defined as how much or little one feels an emotion) during a particular activity (Hetland, 2022; Hetland and Vittersø, 2012). While the Feelometer focuses on measuring emotions, we adapted the tool to capture more complex experiences of learning moments that learners notice. Figure 2 shows an initial development sketch for the Reflectometer.

With the Reflectometer (see Figure 1) we wanted to capture when participants experienced learning (or when the learning situations they encountered stimulated reflection and deep learning). This was done by asking participants to document their Key Learning Moments along a timeline that covered windows of time before, during, and after a learning session. Such KLMs could involve "aha moments" where

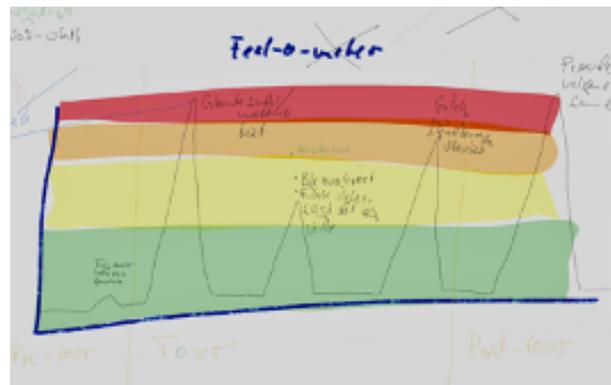


Figure 2: Showing initial development sketch of the Reflectometer. During the earlier stages of the development the Reflectometer had various names, among others 'The Feel-o-meter' as well as the 'Dis-locator' (which we thought sounded a bit too brutal).

learners felt that things fell into place (Liljedahl, 2005) – what Barnes (2000) calls “magical moments”, or other kinds of moments, such as disruptive moments enabling double-loop learning (Argyris, 2015), when participants discovered discrepancies or new connections or reached a notably deeper understanding of a phenomenon. For each of the identified moments, they were asked to describe the situation, their feelings, thoughts, and actions they took, as well as any consequences of these actions by answering six questions:

- What happened?
- When and where did it happen?
- What emotions did you experience?
- What were you thinking?
- What did you do?
- Were there any specific consequences of the event?

Participants could write the comments for each peak right on the page or on a separate sheet.

## 2.2 Participants

Ten students from a season-long avalanche course in Norway participated in the study. The group included 2 women and 8 men, ages 25 to 68. The students arrived with basic knowledge of alpine outdoor activities and winter backcountry travel. Two instructors, each with over five years of experience teaching avalanche courses, led the course.

## 2.3 Procedure and training

All students and instructors underwent a 30-minute training session on using the Reflectometer. The training covered the tool's functionality, explained the axes (X=time, Y=intensity of learning experience), and provided guidelines on identifying and describing KLMs. Participants learned to consider the before, during and after phases of the learning session timeline. Specific examples were given to illustrate the method without influencing individual experiences, ensuring each participant could define their own KLMs. Following the session, participants were asked to visually mark the intensity of their KLMs and provide brief descriptions by answering six guiding questions.

## 2.4 Analysis

We analyzed all reported KLMs from participant and instructor Reflectometers. Alexander et al. (2009) defines learning as a complex and multidimensional process resulting in lasting changes for individuals or groups that changes how they perceive and understand the world and thus respond to it emotionally, cognitively, and behaviorally. Thus, KLMs had to fulfill the following criteria. They needed to be: (1) intense (a peak on the timeline), (2) being revelatory or dislocatory in some way, with (3) some kind of thought, feeling or action associated with them, and (4) indicative of a change in understanding, thinking, feeling, and/or doing.

During analysis we especially looked for reports on reflective practices, double-loop learning and how reflection changed participants' underlying ways of understanding (thinking and feeling about) and acting in the world. Signs of change and transformative learning.

## 3. WHAT HAVE WE LEARNED?

We first and foremost learned that instructors can glean a lot from paying attention to when learning is happening, and in which way it is happening, for the

course participants. The Reflectometer reliably captured participants' Key Learning Moments (see Figure 3) which in turn created some Key Learning Moments for the instructors, thus initiating two-way learning.

Figure 3 below shows how Key Learning Moments can be reported by course participants.

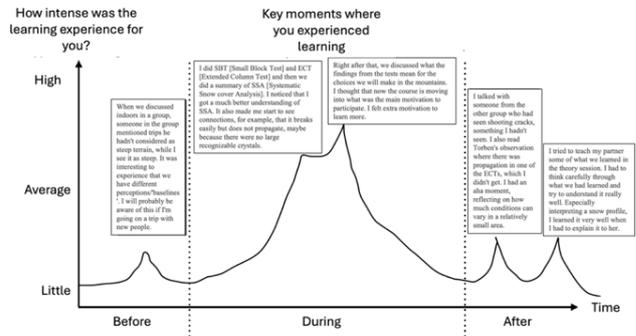


Figure 3: Showing five peaks of various intensity representing five unique Key Learning Moments (one before, two during, and two after a learning session) for one of the participants of the study and how that participant reflects on their learning experiences.

From the reported learning moments, it is possible to identify certain types of learning moments, such as dislocatory or disruptive moments that enable participants to realize discrepancies between what they think they do, and what they do. Such moments are considered important for stimulating double-loop learning and the revision of underlying concepts of understanding and how one thinks about the world (Argyris & Schön, 1974; Hesjedal, 2020; Schön, 1987, 2017). This is especially important in avalanche education. Avalanches are a natural hazard that can be triggered by a single person. Whether or not this is likely to happen depends on the environmental conditions such as snowpack stability, steepness of terrain and the interaction between the backcountry skier and the environment (Statham, 2008). Thus, conceptually understanding the uncertainties related to human interaction and the environmental conditions such as the spatial variability of the snowpack, but also how one's own actions influence the risk of being caught by an avalanche, are decisive for traveling safely in winter backcountry terrain. See Dassler et al., (2023) for a description of several examples of disruptive learning moments relating to the environment, human factors as well as teaching practices.

Reflectometers were relatively easy and reasonably fast to fill out for the participants, and the instructors not only acquired insights into when and what kind of learning was happening for the participants, but they could also use it to assess the (in)effectiveness of their own teaching and adapt the course accordingly. For instance, Reflectometer reports helped instructors identify what kind of learning moments triggered a revision in how participants understood, thought,

and felt about the environmental and group processes – including their own behavior, and whether this had any consequences for their learning or intended future behavior. This happened once, for example, when participants realized that they had entered avalanche terrain even though they had just agreed on not doing so (see Dassler et al., 2023). Such uncomfortable dislocatory moments could be used as a template to create similar disruptive situations that would stimulate participant learning.

Furthermore, the Reflectometer reports also made it possible for the instructors to identify when there was overlap between when they expected participants would have high intensity learning experiences, and when such learning happened for the participants. Some of these realizations were uncomfortable and akin to dislocatory moments showing the instructors that learning was not happening when they thought it would.

Also, Reflectometer reports helped the instructors discover in which instances focusing on teaching hard skills lead to learning, and when teaching other theoretical and practical skills, such as effective communication or the courage to speak up in socially awkward settings was more important.

Even though most of the participants' highly intensive learning moments happened during learning sessions on the mountain, participants also reported peaks both before and after these sessions. These peaks were indicative of a couple of things:

(1) That learning and reflecting on experiences was happening both before, during and after a learning session (see Figure 4). Especially the learning that is going on before and after a course day is usually invisible to the instructor. Thus, capturing such moments provides instructors, among other things, with powerful insights into the thoughts and feelings participants had prior to and after a learning session. Reports could show, for instance, when participants were uncertain about the group setting and their own role in it. This was important information for the instructors that needed to be addressed to create a constructive learning environment.

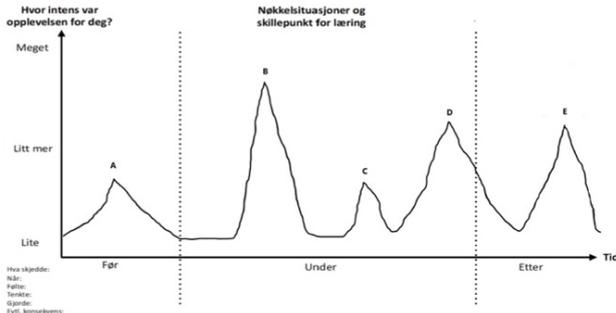


Figure 4: Showing peaks both before, during and after a learning session. The description of these peaks created valuable insights

into emotional and cognitive processes going on for the participants that were invaluable for adapting the course to participants' learning needs.

(2) That debriefs where participants could reflect on their learning experiences were important for deep learning and establishing reflective practices (see Figure 5). Interestingly, these debriefs, although formally implemented at the end of each course day, did not need to be instructor-led debriefings. Participants found that once they got used to talking about their experiences, informal debriefs, such as conversations in the car on the way home or explaining what they had learned to their partners waiting for them at home and justifying their decisions (e.g. to ski a potentially hazardous slope), were as important as formal debriefs at the end of the day, if not more so.

As one participant wrote: *"I reflected on the conversation with Aiden (name changed). I have previously reflected on poor choices, but this is probably the first time I have carefully thought about it. Are there any situations where I could have actually been caught in an avalanche? I don't know what to take from this as a lesson yet, but it is quite unsettling to try to think carefully about it. It's probably something I will reflect on a lot over the next few days."*

Another participant reported the following learning effect when trying to teach their partner what they had learned during the day: *"I tried to teach my partner some of what we learned in the theory session. I had to think carefully about what we learned and try to understand it extra well. Especially explaining a snow profile, I learned it especially well when I had to explain it to her."*

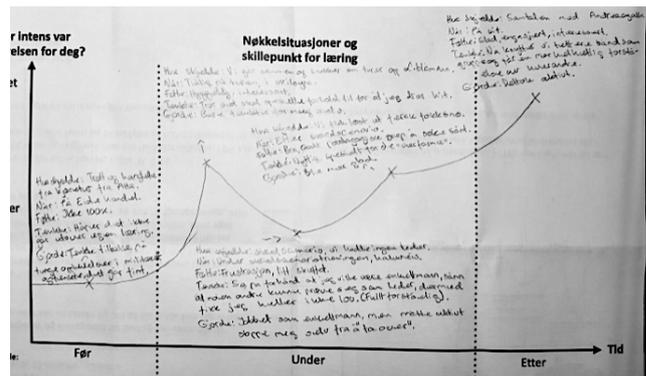


Figure 5: Showing a highly intense peak after the learning session on the mountain and when getting back indoors. This peak represents a debrief in the form of a reflection-based conversation with an avalanche survivor. This conversation, participants reported, triggered a lot of reflection on their own practices and how human behavior affects avalanche risk. Especially how the choice of touring buddies might affect the risks they are willing to take. After realizing how effective this reflection-based conversation was instructors attempted to include several such discussions, for example, on the topic of risk and uncertainty with an influential local steep skiing legend, into the course.

One of the most unexpected findings happened when participants started using the Reflectometer to report dislocatory moments from their private tours. One course participant writes: *“Trip with Jack (name changed). I was scared and uncertain. I thought: is there a greater avalanche risk here than Jack thinks? Could the wind slab turn into an avalanche when we reach the starting zone? Are [the layers in the snow] bonded well enough? Should we turn back?”*

We suggest that participants using the Reflectometer outside a course setting shows the multifaceted, usefulness and ease of use of the Reflectometer to stimulate reflection on and learning from experiences.

In summary, we found that the Reflectometer is a powerful teaching and learning tool that can aid in:

- 1) capturing key learning moments such as disruptive moments that can stimulate double-loop learning and transformative change,
- 2) supporting development of course participants reflective practice, and
- 3) initiating two-way learning for the instructors by providing insights on participants' learning and essential feedback for instructors.

#### 4. WANT TO TRY THE REFLECTOMETER AT YOUR NEXT COURSE?

The Reflectometer is a flexible teaching and learning tool that can easily be used by everyone, anywhere. It can be adapted to various course settings, and is not limited to avalanche education.

If you want to try out the Reflectometer, it is available at [www.reflectometer.eu](http://www.reflectometer.eu) or through the QR-code below.



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