CHALLENGES AND PRIORITIES IN AVALANCHE EDUCATION: A SEQUENTIAL MIXED-METHODS STUDY OF NORWEGIAN INSTRUCTORS' PERSPECTIVES ON TEACHING AND LEARNING OUTCOMES

Tim Dassler[1,2,*], Richard Fjellaksel[1,3], Linda Hallandvik[1,4], Andrea Mannberg[1,5], Tarjei Tveito Skille[1,2], Karin Elisabeth Sørlie Street[1,6]

[1] CARE Center for Avalanche Research and Education, UiT The Arctic University of Norway
[2] Department of Psychology, UiT The Arctic University of Norway
[3] Department of Health and Care Sciences, UiT The Arctic University of Norway
[4] Department of Sport, Food and Natural Sciences, Western Norway University of Applied Sciences
[5] School of Business and Economics, UiT The Arctic University of Norway
[6] Department of Pedagogy, Religion and Social Studies, Western Norway University of Applied Sciences

ABSTRACT: Avalanche education is critical for safety in winter backcountry recreation, yet little is known about instructors' perspectives on the teaching process and learning outcomes from avalanche courses. This study explores the challenges and priorities in avalanche education through the lens of Norwegian avalanche instructors. Employing a sequential mixed methods approach, we combined a survey including closed and open-ended questions with five focus group interviews. About 35% of the population of certified avalanche instructors in Norway participated in the quantitative part of the study (n = 60). 18 instructors participated in the focus group interviews. Our findings reveal that instructors doubt the feasibility of participants attaining all learning goals in the standard two-to-three-day basic avalanche courses. They perceive certain goals, such as terrain management, as more important, easier to teach, and more likely for participants to attain, relative to other goals. In contrast, topics like snowpack dynamics and human factors in decision-making are considered complex and are often deprioritized due to time constraints and the course structure. Instructors express a need for more pedagogical training and resources to effectively cover these complex topics. The study suggests a re-evaluation of current teaching practices and course structures, emphasizing the importance of adapting to socio-ecological conditions and extending educational offerings beyond basic courses to improve safety outcomes in avalanche terrain.

KEYWORDS: Avalanche education, learning goals, avalanche instructors, mixed methods, avalanche learning

IMPLICATIONS: To improve avalanche education, the following suggestions are made.

Enhance instructor training and foster the creation of professional networks and communities of practice.

Develop evaluation strategies for avalanche courses along with a comprehensive and demonstrably effective set of teaching methods.

Design specialized terrain and forecasting courses, paired with advanced recreational courses that have admission prerequisites.

* Corresponding author address:
Tim Dassler, CARE – Center for Avalanche Research and Education, UiT - The Arctic University of Norway, Faculty of Health Sciences, Department of Psychology
tel: +47 48353465
email: tim.dassler@uit.no

1. INTRODUCTION

Avalanche educational courses aim to help users of avalanche terrain attain skills in avalanche risk mitigation. Learning, of any type, is challenging. It requires time and repetition to build knowledge structures, and reflection to derive wider principles and ensure adaptability (Bransford et al., 2004). Recreational avalanche education is perhaps especially demanding for at least three reasons: First, the recreational courses are voluntary and targeted at people who venture into the mountains during their leisure time. This places constraints on the length of the courses - most introductory avalanche courses are kept short to fit with a modern-day work schedule. Furthermore, in recreational groups it is difficult to enforce the safety procedures typically applied in professional settings. Second, avalanches are rare events with potentially catastrophic consequences. As a result, decisions that put people at elevated risk rarely result in a negative outcome and in the cases it does, the decision-maker might not survive to learn from the experience. When environmental factors are complex and incomplete, the relevant information upon which we base our assessments may not be apparent. In this type of wicked learning environment, making sound judgments and learning from experience is difficult (Hogarth, 2015; Kahneman, 2012; Kahneman and Klein, 2009; Shanteau, 1992). Finally, since there are no formal eligibility criteria to participate in introductory avalanche courses, the knowledge, skills, and motivations of the participants can vary substantially.

In this paper, we report findings from a study on what avalanche instructors perceive most important to teach and the challenges they face during recreational avalanche courses. We consider level 1 courses that follow the standard set by the Norwegian Mountain Forum (NF) in Norway as a case study and ask the following two research questions:

(1) Do instructors perceive any of the NF learning goals to be more important, more difficult to teach, or more likely to be attained by course participants, than others? If so, which are these learning goals?

(2) How do instructors reflect around the NF learning goals, in terms of whether and why they perceive them as important, difficult to teach, and likely to be attained by most course participants?

Learning goals are pivotal in the processes of planning, instruction, and reflection in education (Hall and Smith, 2006). They can serve as mechanisms for influencing and guiding courses towards desired outcomes. However, their value and impact are subjects of debate, often perceived as ambiguous. Their ability to provide clarity and accountability is questioned, with concerns about potential oversimplification and a narrowing focus (Sweetman, 2019;

Havnes and Prøitz, 2016). Constructive alignment between learning goals, learning tasks and evaluation of the learner is considered decisive for achieving desired learning outcomes (Biggs, 2011).

Gaining knowledge about instructors' perceptions about the introductory avalanche course learning goals is important for at least three reasons. First, avalanche instructors are key stakeholders as they are the ones who design and carry out the courses while considering the course requirements, i.e., the learning goals. Instructors are therefore well placed to provide key insights into the introductory courses and how they "work". Second, the reciprocal nature between perceptions and behavior (Bandura, 2001) means that instructors' views and experiences are likely related to how they treat the learning goals in their courses. Finally, knowledge about how avalanche instructors perceive the learning goals is important to evaluate the degree of alignment between avalanche safety theory (the learning goals) and practice (what the instructors report focusing on). As 9 out of 10 deadly avalanche accidents are triggered by victims themselves or someone in their group (Schweizer and Lütschg, 2001), we hope that our research can contribute to fatality prevention through improved avalanche education.

2. RECREATIONAL AVALANCHE EDUCATION IN NORWAY

NF is a national organization, consisting of The Norwegian Trekking Association (DNT), The Norwegian Climbing Federation (NKF) and other organizations with considerable competence in mountain sports, such as Nortind (representative of the International Federation of Mountain Guides Associations in Norway). Playing a pivotal role in structuring avalanche education in Norway, NF holds the authority to train and certify avalanche instructors and standardizes course curriculums, ensuring a consistent and comprehensive educational approach. NF's avalanche course curriculum aligns with other international standards such as AIARE REC 1, 2 or Avalanche Canada AST1, 2 with specific adaptations for Norwegian contexts (e.g., Nordic skiing). The recreational avalanche courses range from one day introductory courses to several days advanced level 2 courses, catering to various skill levels and needs. Beyond level 2 there are no NF-certified recreational courses (only instructor training courses). There are no formal requirements to implement course evaluations or test if participants reach the learning goals on NF courses (Norsk Fjellsportforum, 2018).

Table 1 shows the eight main learning goals for NF recreational level 1 courses (see Norsk Fjellsportforum (2018) for the full set of sub goals).

A	Be able to recognize avalanche terrain
B	Be able to carry out companion rescue
C	Be able to locate information about avalanche danger and snow conditions
D	Have a basic understanding of snow and avalanches
E	Be aware of relevant equipment
F	Understand the significance of one's own motivation
G	Be aware of how participation in a group might impact safe travel
H	Be aware of Norwegian "Friluftsliv" traditions

Table 1. NF (main) learning goals.

3. METHOD

3.1 Study design

We employed a sequential mixed methods design (Ivankova et al., 2006) combining a quantitative survey with closed and open-ended questions with focus group interviews. The design was sequential, in that themes emerging from preliminary analyses of the questionnaires were used to inform the focus and questions of the interview guide in the (subsequent) focus-group interviews. Furthermore, themes and findings from the focus group interviews informed certain decisions during the analytical process of the questionnaire data (e.g., to use the main learning goals rather than the sub-goals, see Measures section).

3.2 Participants

We sent out an invitation to participate to all certified instructors in Norway via email (N = 135). We recruited participants to the qualitative survey via a question at the end of the survey, and via personal contacts. Sixty instructors (44%) provided written consent to participate in the survey. Of these, 50 provided background information. Mean age in the sample was 45 years (Min = 29, Max = 67, SD = 9.21), and 82% identified as male. Average experience as an instructor in the sample was 6 years (Min = 1, Max = 22, SD = 4.54). The NF standard requires that courses are three days long. 44% of our participants taught 3-day level 1 courses, while 36% taught 2-2.5 or a mix between 2- and 3-day courses. 20% taught courses of either shorter or longer length. Nearly 70% stated that they followed the NF guidelines to a high or a very high degree. The sample instructors were active in 10 of the 15 regions in Norway.

Eighteen instructors (13 males and five females, age range: 21-66) were recruited from the survey participants for the focus group interviews.

3.3 Measures

The survey consisted of closed and open-ended questions. The close-ended questions asked instructors to rate the importance, difficulty, and likely participant attainment of the NF learning goals (main and sub-goals) on a scale from 1 (= not important /difficult/likely) to 5 (= very important/difficult/likely, see supplementary materials). In this paper, we only present the results for the instructors' ratings of the main learning goals. One motivation for this is that the participants' responses to the sub-goals did not reflect their responses to the main goals. Another is that the focus group interviews showed that when planning their courses, instructors consider the main learning goals to a larger degree than the sub-goals.

The eight open-ended questions aimed to capture information not included in the closed questions (e.g., topics not included in the NF-learning goals). The first question targeted what the instructors think is most important that participants learn during a level 1 avalanche course, and why. This question was asked prior to all other survey questions. The aim of the remaining open-ended questions was to allow instructors to comment on their answers to the closed questions. Specifically, we asked for information on missing themes in the learning goals (importance), learning goals not taught (difficulty), and learning goals they felt most participants already knew before starting on an introductory course (attainment).

The focus groups were conducted by two experienced interviewers with a background in avalanche education. Five focus groups with 18 instructors were facilitated. The overall sample size was guided by information power (Malterud et al., 2016). Between three and four instructors participated in each interview. A dynamic approach was used, where the interview questions were adapted after each focus group, to follow up on emerging themes. In this way we aimed to move beyond what the instructors perceived as important, difficult, and likely attained by participants, to better understand how they reflected on the experiences and reasons that motivated these perceptions.

3.4 Ethics

All participants provided written consent to participate in the study. Focus group conversations were recorded, transcribed, anonymized, and stored on an encrypted university server. The study was approved by the Norwegian Agency for Shared Services in Education and Research (SIKT).

3.5 Analyses

For the survey data, we used the Wilcoxon signed-rank test to investigate differences in perceptions between the learning goals. Not all participants an-

swered all the questions. To make the analysis consistent while maintaining as large a sample as possible, we based the analysis on complete answers for each section. Open questions were analyzed following Braun and Clarke's (2006) approach for thematic analysis.

For the focus group data, we used the collective qualitative analysis approach by Eggebø (2020) and practical thematic analysis by Saunders et.al. (2023). The researchers coded and discussed the empirical findings within the context of avalanche education and pedagogics to address the research questions both through online meetings and in-person analysis workshops. This approach formed the foundational basis for relevant theories used to interpret the empirical findings. During analyses emerging themes were mapped out, analyzed, and compared to develop a theme table and shared understanding of the data.

4. RESULTS

4.1 *Instructors' perceptions on the importance, difficulty to teach and attainment of NF learning goals*

Figures 1a – 1c show instructors' perceptions of the main learning goals in terms of (a) importance, (b) difficulty to teach, and (c) participant attainment. The bars illustrate the mean responses while the lines at the top of each bar illustrate the standard deviation around this mean (where a shorter line indicates higher degree of agreement between instructors).
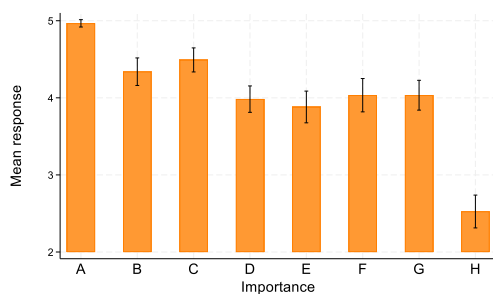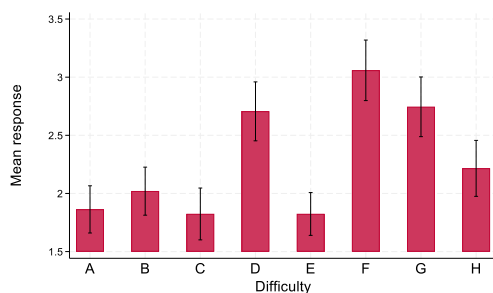

Figure 1a. Perceived importance of learning goals.

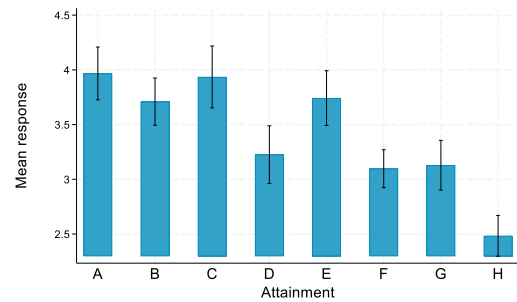**Figure 1b.** Perceived difficulty to teach learning goals.

Figure 1c. Perceived participant attainment of learning goals (A: Terrain, B: Rescue, C: Forecast, D: Snow, E: Gear, F: Motivation, G: Group, H: NF traditions).

As can be seen in Figure 1a, the instructors on average think that almost all learning goals are either important (4) or very important (5). The exception is Norwegian outdoor traditions (H), which on average is deemed to be less than somewhat important (3). Our statistical tests show that learning goal A (Terrain) is perceived as significantly more important than all other learning goals (p<0.01), and that learning goal H is perceived as significantly less important than all learning goals (p<0.01). We further find that learning goals B (Rescue) and C (avalanche forecast) are perceived as more important than learning goals D – H (p<0.01). There are no statistical differences between the means of learning goals D through G.

Figure 1b indicates that none of the goals are perceived as very difficult to teach. However, our tests show that learning goals D (snow), F (motivation), and G (group) are perceived as more difficult to teach than learning goals A – C and E. The differences are significant at 5% or lower.

Finally, figure 1c suggests that instructors on average think it is likely that course participants attain learning goals A – G at least "to some degree" (3). Our statistical tests show that learning goals A, C, and E are perceived as more likely attained than the other learning goals (p < 0.05 except for difference between B and C, p < 0. 1). We do not find any difference in instructors' perceptions of likely participant goal attainment between learning goals A, C, and E. Goals D, F, and G are perceived as equally likely to be attained by most avalanche course participants. Goal H is perceived as least likely attained.

The thematic analysis of the open-ended questions confirms the importance of learning goal A. Almost all instructors (n = 56) highlight the essentiality of learning how to identify avalanche terrain, using map tools and/or being able to implement risk reducing strategies to travel safely in the mountains. However, while the responses to the closed questions suggest that learning goal C and B are more important than the remaining learning goals, the responses to the

open questions show that the topics related to snow and avalanche knowledge are mentioned almost as often (N = 17) as topics related to learning goal C (avalanche and weather forecasts, N = 18), and more often than learning goal B (companion rescue, N = 10). Many instructors emphasise how important it is that students understand what is required for an avalanche to occur, how complex and difficult assessment of avalanche risk is, and that they want to motivate participants to learn more about snow and avalanches. In other words, the instructors emphasise the importance of motivating students to engage in learning after the course to a larger degree than they place emphasis on attaining learning goal D during the course. Note that stimulating interest beyond a course is not part of any of the pre-established NF learning goals. 14 instructors describe topics related to learning goals F and G (human factors). Many of these use more general terms (e.g., being aware of human factors) than the ones used in the learning goals.

4.2 *Instructors' reflections on the NF learning goals*

From the instructors' reflections on the learning goals during the focus groups, three overarching themes emerged. These themes include several sub-themes each. See Figure 2.
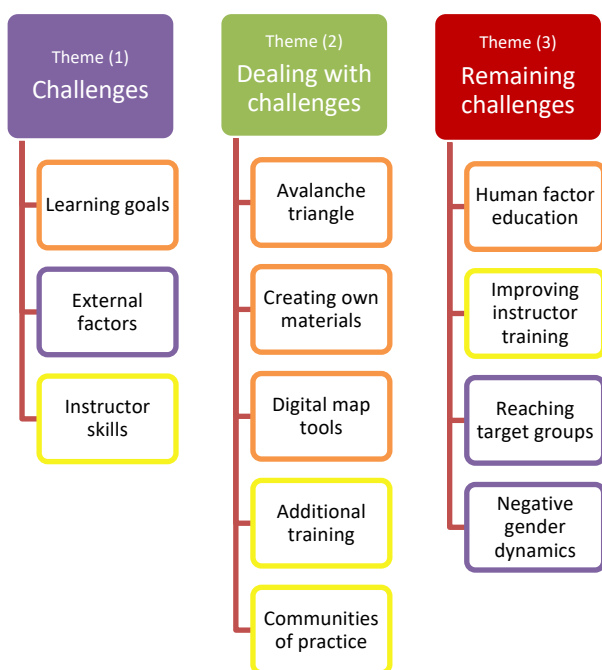

Figure 2. Emerging themes and sub-themes from focus groups with certified avalanche instructors in Norway. Color coding of sub-themes shows relation between themes. For example, the challenges related to the learning goals (orange) are addressed by instructors using the avalanche triangle, creating their own teaching materials and employing digital map tools (all orange) in teaching. Even though instructors discuss different ways of how to 'deal with' human factor education (orange), this remains a challenge.

Theme (1): How do instructors reflect on experienced challenges?

The avalanche instructors identify three key challenges related to the **learning goals** in themselves. The sheer number of learning goals makes it difficult to fit all goals in a three-day course. In addition, many of the learning goals are vaguely described and their meaning is therefore ambiguous. Related to this, the instructors feel that there is a lack of alignment between the main goals and their sub-goals.

Some of the challenges faced are caused by **external factors.** The instructors highlight that the course setting (e.g., weather, terrain available, snow conditions, participant skills, motivation, and composition of skills and motivation in the course group) create constraints on which learning goals can be taught. For example, instructors who teach in regions with mellow terrain available and relatively stable snowpack found it easier to adapt courses to participants and conditions compared to instructors from areas with more complex snowpack and terrain. However, instructors also face difficulties teaching terrain management in easier terrain as this type of terrain does not allow for 'sharp' decisions. Therefore, although instructors highlight the importance of teaching about terrain, they often face tangible challenges to implement terrain management in praxis. Female instructors further grapple with stereotypes related to teaching about human factors (e.g., that male participants labelled this topic as "girly talk" or "girl stuff and psychology and stuff like that").

In part due to the challenges related to the learning goals and the external factors, but also due to the structure of instructor education, instructors experience uncertainty and inadequacy related to **their own skills**. They express a lack of pedagogical training and access to didactic tools. This leaves them wondering about the effectiveness of their teaching methods. Especially newly certified instructors express that they feel pedagogically and didactically unprepared for the job.

Theme (2): How do instructors deal with experienced challenges?

In dealing with the above challenges, instructors state that they use the **avalanche triangle** to structure their teaching, rather than the NF learning goals. However, they also state that they prioritize teaching terrain and deprioritize snow and human factor education. The main stated reason for doing so is the complexity of snow and human factors, which is further exacerbated by the need to consider these factors in relation to one another. In addition, although weather is an important part of the avalanche triangle, it is only discussed peripherally by the instructors and mainly regarding how bad weather can be used to facilitate human factor education.

To deal with time and other course restrictions, instructors use **digital tools** and create **own teaching materials** such as video lectures and seminars. For example, to handle time constraints instructors use video materials and online seminars that can be accessed before and after the course. Furthermore, instructors seek to employ digital map tools rather than traditional paper maps to teach terrain management more effectively.

The instructors' solution to challenges related to their own skills, is to educate themselves through **additional training**. Several instructors state that they have enrolled in advanced avalanche courses (e.g., snow observer courses) that are not part of the formal instructor training. Many also seek to create **communities**, in which they can share their experiences, **practice** their skills, and develop new ones by learning from and with other instructors.

Theme (3): What are the remaining challenges?

Although the instructors have developed mitigation strategies to deal with the challenges they face, there are challenges that remain unsolved. The instructors feel that level 1 avalanche courses are 'not designed for' teaching about **human factors**. Despite their efforts to educate themselves, they further voice that they struggle with teaching "complex" snowpack assessment and "complex" and "abstract" human dynamics effectively. Many express a need for **improved instructor training**, both in terms of technical and pedagogical skills. **Reaching participants** with different skill sets and motivations is a central dilemma requiring pedagogical skills not all instructors feel they have acquired during their training. Some instructors questioned whether participants, who are highly motivated to travel in avalanche terrain, should even be a target group of level 1 courses (as the aim is often to teach participants how to avoid dangerous terrain). Finally, the impact of **negative gender dynamics** and stereotypes remains a challenge.

5. SUMMARY OF FINDINGS AND WAY FORWARD

Due to the challenges associated with the learning goals, the influence of external socio-ecological factors, as well as a perceived lack of skills, instructors attempt to deal with this reality by simplifying and deprioritizing certain topics when teaching level 1 courses. Instead of the NF learning goals many instructors report using the Avalanche Triangle to organize their courses. Instructors focus more on the overarching dimensions of terrain, snow, weather, and humans, rather than strictly following NF learning goals. At the same time instructors prioritize terrain over other more complex and dynamic dimensions in the avalanche triangle.

The good news is that instructors prioritize important learning goals and essential skills for safe winter backcountry travel. This chimes well with previous studies that emphasize the importance of terrain (Fredston and Fesler, 2011; Hallandvik et al., 2016; Statham et al., 2018; Wagner and Hardesty; 2014), using the avalanche forecast actively (Engeset et al., 2018; Fisher et al., 2022), and companion rescue (Edgerly and Atkins, 2006; Genswein et al., 2022; Wallner et al., 2019). But instructors also de-prioritize teaching about human and snowpack dynamics, which are decisive aspects for traveling safely in the winter backcountry, due to a variety of factors. Additionally, instructors deprioritize teaching 'outdoor' traditions and values connected to nature.

The de-prioritization of teaching snowpack and human dynamics at level 1 courses is corroborated and may be partially explained by the survey findings. The instructors report that these goals are difficult to teach and unlikely attained by participants, but also highlight the importance of motivating students to engage in learning after the course.

Even though instructors try to find their own ways in dealing with these challenges, certain issues are left unresolved. These include effectively teaching complex topics such as snowpack dynamics and human decision-making at level 1 courses, improving instructor training and skills, engaging course participants with diverse motivations, and addressing external socio-ecological factors such as stereotyping, that negatively impact the content and outcomes of avalanche courses.

5.1 *Introducing the Avalanche Education Triangle*

Many of the uncertainties and challenges instructors express in our study may be explained by the seeming lack of constructive alignment. *Constructive alignment* is when learning outcomes, teaching activities, and assessment tasks are aligned to ensure that students achieve the desired learning objectives (Biggs, 2011). With no assessment or evaluation of recreational level 1 avalanche courses both participants and instructors lack important feedback. Thus, we know little about the degree to which the current learning goals are effective mechanisms in terms of bringing about desired participant outcomes.

Increasing constructive alignment through ongoing evaluation, together with addressing socio-ecological factors and instructor skills may improve instructors' teaching effectiveness and participants' learning outcomes. This can be visualized in what we call the **Avalanche Education Triangle** (see Figure 3).
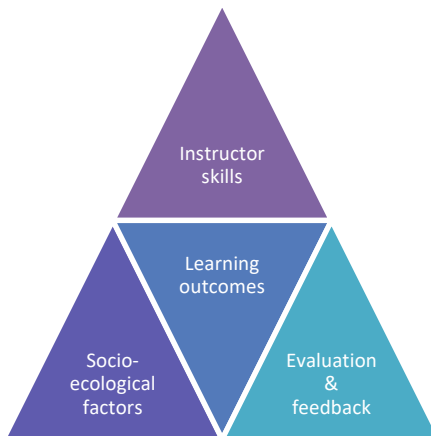
Figure 3. Showing the three dimensions influencing learning outcomes of avalanche courses.

6. CALL FOR ACTION

Based on our findings we suggest three implications for avalanche education.

Improving instructors training and communities of practice

Many instructors feel that their training does not provide them with sufficient technical and pedagogical skills. Consequently, they enroll in additional courses to acquire the skills they believe are essential for teaching recreational avalanche courses. Instructors also emphasize the need to practice their skills with peers, noting that such practice may be even more valuable than formal training. However, they often find it challenging to establish communities of practice. Therefore, a key implication is to enhance the technical and pedagogical aspects of instructors' training and to facilitate communities of practice or professional networks.

Development of evaluation methods and creation of a comprehensive set of teaching methods

Implementing systematic evaluation methods and creating a comprehensive set of teaching methods could aid in refining teaching practices, adjust curriculum content based on actual learning outcomes, and ultimately enhance the overall quality of avalanche education. This approach would increase alignment between learning tasks, goals, and evaluation and could thus contribute to a reduction of the number of learning goals. This could also support participants in acquiring the skills and knowledge necessary to safely navigate avalanche terrain and ensure instructors receive vital feedback on their teaching performance. The study's findings illustrate the need for targeted educational resources and the continuous improvement of instructional methods.

Diversifying avalanche courses

We propose the introduction of a specialized course focused on terrain and weather forecasting. For example, a *backcountry touring* course. By streamlining course content to concentrate on these critical areas, we can ensure that all participants receive essential and targeted knowledge that directly enhances their safety in avalanche-prone environments. This approach allows instructors, regardless of their confidence levels, to effectively deliver key content that is vital but often underestimated in its complexity.

Furthermore, we recommend introducing *additional advanced courses with prerequisites* focused on snowpack and human dynamics. These courses demand a higher level of competence from both instructors and participants. By establishing a progressive sequence of courses that build upon each other, where participants must meet specific prerequisites (e.g., skiing skills and terrain knowledge), we can ensure that learners are adequately prepared and that instructors are well-equipped to teach advanced topics. This structured approach promotes continuous learning and deeper engagement with complex dimensions, addressing the identified need for fostering ongoing educational curiosity and competence.

By implementing these strategic changes, avalanche education in Norway—and beyond—can significantly improve, resulting in better-prepared instructors and safer, more skilled participants in avalanche terrain. This holistic approach will ultimately elevate the standard of avalanche safety training, ensuring it meets the complex demands of teaching essential survival skills in the challenging environments of the winter backcountry.

The role of values in avalanche education

Teaching Norwegian outdoor traditions (Friluftsliv) is deprioritized by instructors. This lack of priority likely stems from the perception that there are too many learning goals to cover in a short level 1 course, leading instructors to focus on what they deem most useful. This tendency suggests that instructors view avalanche courses more instrumentally, focusing on practical skills and knowledge essential for survival, such as terrain navigation, using the avalanche forecast for planning safe trips, and companion rescue. In contrast, 'Friluftsliv' traditions encompass broader values that guide our interaction with nature. They are about the 'why' and the 'how' of living a life connected to nature. Despite their relevance in today's world, especially considering the impact of climate change and loss of biodiversity, these values are challenging to translate into specific, actionable learning goals. The lack of emphasis on such values may indicate a need for a shift in instructional priorities. If these values are considered important, they should be explicitly integrated into instructor training and certification programs. Is there a need for a discussion about the role of values in avalanche education?

REFERENCES

Bandura, A.: Social cognitive theory: An agentic perspective, ANNU REV PSYCHOL, 52, 1–26, https://doi.org/10.1146/annurev.psych.52.1.1, 2001.

Biggs, J.: Teaching for quality learning at university.: what the student does, 4th ed., Open University Press, 2011.

Bransford, J. D., Ed, Brown, A. L., Ed, and Cocking, R. R., Ed: How People Learn: Brain, Mind, Experience, and School: Expanded Edition, 2nd ed., Washington, D.C: National Academies Press, Washington, D.C, https://doi.org/10.17226/9853, 2004.

Braun, V. and Clarke, V.: Using thematic analysis in psychology, Qualitative research in psychology, 3, 77–101, https://doi.org/10.1191/1478088706qp063oa, 2006.

Edgerly, B. and Atkins, D.: Strategic Shoveling: The Next Frontier in Companion Rescue, 2006.

Eggebø, H.: Kollektiv kvalitativ analyse, Norsk sosiologisk tidsskrift, 4, 106–122, https://doi.org/10.18261/issn.2535-2512-2020-02-03, 2020.

Engeset, R. V., Pfuhl, G., Landrø, M., Mannberg, A., and Hetland, A.: Communicating public avalanche warnings – what works?, Nat. Hazards Earth Syst. Sci., 18, 2537–2559, https://doi.org/10.5194/nhess-18-2537-2018, 2018.

Fisher, K. C., Haegeli, P., and Mair, P.: Exploring the avalanche bulletin as an avenue for continuing education by including learning interventions, Journal of outdoor recreation and tourism, 37, https://doi.org/10.1016/j.jort.2021.100472, 2022.

Fredston, J. A. and Fesler, D.: Snow Sense: A Guide to Evaluating Snow Avalanche Hazard, Alaska Mountain Safety Center, 132 pp., 2011.

Genswein, M., Macias, D., McIntosh, S., Reiweger, I., Hetland, A., and Paal, P.: AvaLife-A New Multi-Disciplinary Approach Supported by Accident and Field Test Data to Optimize Survival Chances in Rescue and First Aid of Avalanche Patients, Int J Environ Res Public Health, 19, 5257, https://doi.org/10.3390/ijerph19095257, 2022.

Hall, T. J. and Smith, M. A.: Teacher Planning, Instruction and Reflection: What We Know About Teacher Cognitive Processes, Quest, 58, 424–442, https://doi.org/10.1080/00336297.2006.10491892, 2006.

Hallandvik, L., Aadland, E., and Vikene, O. L.: Terrain Classification of Norwegian Slab Avalanche Accidents, Journal of outdoor recreation, education, and leadership, 8, 136–147, https://doi.org/10.18666/JOREL-2016-V8-I2-7695, 2016.

Havnes, A. and Prøitz, T. S.: Why use learning outcomes in higher education? Exploring the grounds for academic resistance and reclaiming the value of unexpected learning, Educ Asse Eval Acc, 28, 205–223, https://doi.org/10.1007/s11092-016-9243-z, 2016.

Hogarth, R. M., Lejarraga, T., and Soyer, E.: The Two Settings of Kind and Wicked Learning Environments, Current Directions in Psychological Science, 24, 379–385, 2015.

Ivankova, N. V., Creswell, J. W., and Stick, S. L.: Using Mixed-Methods Sequential Explanatory Design: From Theory to Practice, Field Methods, 18, 3–20, https://doi.org/10.1177/1525822X05282260, 2006.

Kahneman, D.: Thinking, fast and slow, Penguin Books, London, 2012.

Kahneman, D. and Klein, G.: Conditions for Intuitive Expertise: A Failure to Disagree, Am Psychol, 64, 515–526, https://doi.org/10.1037/a0016755, 2009.

Malterud, K., Siersma, V. D., and Guassora, A. D.: Sample Size in Qualitative Interview Studies: Guided by Information Power, Qual Health Res, 26, 1753–1760, https://doi.org/10.1177/1049732315617444, 2016.

Norsk Fjellsportforum: Grunnkurs skred alpint - Mal for opplæring, https://fjellsportforum.no/wp-content/uploads/2018/01/2018_Grunnkurs_Skred_Alpint-1.pdf, 2018.

Saunders, C. H., Sierpe, A., Plessen, C. von, Kennedy, A. M., Leviton, L. C., Bernstein, S. L., Goldwag, J., King, J. R., Marx, C. M., Pogue, J. A., Saunders, R. K., Citters, A. V., Yen, R. W., Elwyn, G., and Leyenaar, J. K.: Practical thematic analysis: a guide for multidisciplinary health services research teams engaging in qualitative analysis, BMJ, 381, e074256, https://doi.org/10.1136/bmj-2022-074256, 2023.

Shanteau, J.: Competence in experts: The role of task characteristics: Special Issue: Experts and expert systems, Organizational behavior and human decision processes, 53, 252–266, 1992.

Statham, G., Haegeli, P., Greene, E., Birkeland, K., Israelson, C., Tremper, B., Stethem, C., McMahon, B., White, B., and Kelly, J.: A conceptual model of avalanche hazard, Nat Hazards, 90, 663–691, https://doi.org/10.1007/s11069-017-3070-5, 2018.

Sweetman, R.: Incompatible enactments of learning outcomes? Leader, teacher and student experiences of an ambiguous policy object, Teaching in Higher Education, 24, 141–156, https://doi.org/10.1080/13562517.2018.1469486, 2019.

Schweizer, J. and Lütschg, M.: Characteristics of human-triggered avalanches, Cold Regions Science and Technology, 33, 147–162, https://doi.org/10.1016/S0165-232X(01)00037-4, 2001.

Wagner, W. S. and Hardesty, D.: TRAVEL ADVICE FOR THE AVALANCHE PROBLEMS: A PUBLIC FORECASTING TOOL, in: Proceedings, International Snow Science Workshop, Banff, 2014.

Wallner, B., Moroder, L., Brandt, A., Mair, P., Erhart, S., Bachler, M., Putzer, G., Turner, R., Strapazzon, G., Falk, M., and Brugger, H.: Extrication Times During Avalanche Companion Rescue: A Randomized Single-Blinded Manikin Study, High Altitude Medicine & Biology, 20, 245–250, https://doi.org/10.1089/ham.2019.0021, 2019.