

Review of

Key learning moments as predictors for understanding snowpack dynamics during a season-long avalanche course?

by T. Dassler et al.

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Dear authors, dear editor,

please find below my comments on the manuscript. Please note that I lack a background in education and psychology, so my review focuses mainly on the structure and clarity of the *Material and Methods* and *Results* sections. Despite this, I hope my feedback will help enhance the manuscript.

- 5 This study examines the learning outcomes during and after a season-long avalanche course in Norway. It evaluates the learning outcomes related to snowpack dynamics and stability based on the responses of ≤ 10 individuals across three course modules, using surveys. Although the topic is highly relevant for enhancing avalanche education, the small sample size may limit the generalizability of the findings. The article is submitted to appear in NHESS as part of the *ISSW 2023 special issue*.

1 General remarks

- 10 – **Size of the data set:** The study relies on a very small data set ($N \leq 10$), which significantly affects the robustness and generalizability of the findings. Given that the study relies on findings from a single avalanche course, the study is more appropriately characterized as a case study, rather than one allowing for broad interpretations. The small sample size is a key limitation that currently is only briefly mentioned (line (L) 573). Please discuss this limitation more thoroughly. To bolster your findings, compare them with results from similar studies. While I am not familiar with this research area and cannot suggest specific literature, a quick search revealed at least one relevant study presented at an ISSW, which could support some of your results (Pfeiffer and Foley, 2006). In my view, comparing your findings with those from similar studies should be the first step in the discussion, before delving into the implications of your results.
- 15
- 20 – The title of the manuscript suggests that the impact of key learning moments (KLM) on learning outcomes is the primary focus of the study. While the theoretical idea behind KLM is introduced in Sect. 1.3, detailed information about the KLM provided by respondents are not included in the manuscript (L246-249), leaving it unclear what they typically are and how they relate to snowpack stability. Instead, the reader is referred to another paper (currently under review), which I had to read to understand better what KLM are, at least through examples. The analysis exclusively analyzes the number of KLM, but without a clear explanation or examples of what these KLM were and how they relate to learning outcomes or the question, "Why is it safe to ski this slope?", thus limiting the significance of this analysis. - Please reconsider

25 whether KLM should be prominently featured in the title, or, preferably, provide significantly more information to the reader. If KLM were categorized according to a specific annotation scheme, I suggest including that information in the manuscript as well.

– Despite the small data set, the Results section was challenging to follow due to the way data and methods were presented, making it difficult to locate relevant information. Please refer to my specific comments and recommendations below to
30 make these sections more reader-friendly.

– Reading the study made me wonder: why does the study focus exclusively on learning outcomes related to *snowpack dynamics/stability*, and not on important topics related, for instance, to tour planning (beside snow and weather information), terrain choices, group dynamics, and rescue? Are these considered less important? For instance, there is the saying: "If uncertainty or the snowpack is the problem, terrain is the solution." (website) - Please explain to the reader
35 why the focus of this study (or the courses?) was on snowpack dynamics.

– And a rather general comment: The Introduction, and particularly the Discussion, seem rather lengthy. As most of what is introduced and explained is far away from my research expertise, I just wonder whether these could be more focused on the main points relevant to the study.

In the following, please find some more detailed comments. These relate primarily to the *Material and Methods* and the
40 *Results* sections.

2 Detailed comments

2.1 Title

As mentioned before, if the *key learning moments* aren't explained and analyzed with greater depth, they should probably not be as prominent in the title. Consider mentioning that this is a 'case-study', in the title.

45 2.2 Introduction

In its present structure, the reader has to read to L142-146 and L171-179 to learn about the research objective. Consider moving L142-146 (aims of the study) to the end of the introductory part after L60.

Sections 1.1 to 1.2 provide an extensive literature review on learning. While Sect. 1.3 is clearly relevant for understanding KLM, I feel that parts of Sect.s 1.1 and 1.2 could be more focused on what is relevant for the study.

50 Do you on purpose refer to snowpack dynamics rather than snowpack stability? Or are both relevant? Consider briefly introducing these concepts and why both may be important to teach.

2.3 Methods

When reading the Results section, I struggled to easily find the respective information on course modules, when surveys were conducted, which questions were asked, what the possible answer options were, and how answers and answer options were analyzed or grouped. Please make this section much more reader-friendly including the following (but possibly other elements).

- 55 (1) A figure, probably a time line, which depicts
- the course modules and the respective labels used in the manuscript,
 - when surveys were conducted,
 - how many respondents participated in each survey and how many participated in each module,
 - 60 – the five data sets, which you obtained - and the three, which were analyzed in this study (L233-237),
 - ...

Maybe this doesn't all fit into the same figure.

- (2) A table, here or in the Appendix, including
- the survey questions (and maybe a column with an overarching label?) - For instance, in the Results *competence* and *confidence* are analyzed. Firstly, I struggled finding information on how these were addressed. Secondly, in Sect. 2.2.1, I found it difficult to know which question aimed at answering these points.
 - 65 – the respective answer options (i.e., open text answer) or type of response (i.e., Likert scale)
 - (possibly) the respective number of respondents - if that differed between questions,
 - possibly the mode of analysis - i.e., text interpretation/annotation by researchers, calculation of median, modeling of
 - 70 scores, ...

Summarizing this information in figures and/or tables will assist understanding the Results section.

2.4 Results

An overall remark, though this is my personal perspective on presenting results accessibly: Consider moving more of the results in tables and figures. In the text, I suggest summarizing the results and highlighting particularly important findings with reference to tables and figures.

75 Given the small data set and the varying metrics used for different questions (number of participants, proportions correct, proportions not understood, Likert scale, safe-to-ski score), I suggest using simple descriptive measures like median or modal values to describe the findings complementing the modeled values. Presenting these results in a table may make them easier to interpret. Medians could also be shown in the violin plots.

- 80 – L288-293: Consider moving this information to a table or a barplot rather than listing proportions for each class individually in the text.
- L294-305: Again, these results could probably be visualized using a barplot making it easier to grasp observed changes from one module to the next.
- L346-365: Consider presenting these results in a table. Maybe association plots would be a way to visualize these relationships too? website
- 85

3 Technical comments

- To ease readability, consider using hyphens when three nouns are used in a row throughout the manuscript.
- L60: Reading this statement regarding the relevance of what is being taught in avalanche courses from Landrø et al. (2020), I wonder: how did you ascertain that what was being taught was relevant?
- 90 – L91: Should the three authors listed be known? Either rephrase or provide references to their works.
- L122 and 136: Why are *Key Memorable Events*, *Dislocatory Moments*, and *Key Learning Moments* written in capital letters?
- L185-188 Provide a reference to these tests, as for instance to the operational guidelines. Alternatively, as they don't seem central to the manuscript, consider shortening the list of tests.
- 95 – L267-275: How did you address participants mentioning other reasons for why it was safe to ski? For instance, reasons such as "the slope being small," "skiing one at a time," or "a run-out without any terrain traps" could all be relevant factors that are not related to the snowpack. Wouldn't excluding such reasons potentially obscure the fact that participants made more informed decisions after the season-long course as well?
- L265/269: Out of curiosity: how often did the two raters initially disagree?
- 100 – L279: The (c) should probably be a (d)?
- L279: Provide more explanation to the linear mixed models (LMM) and tests. For instance, a brief explanation why LMM is appropriate. Provide a reference to the *R*-package used for LMM calculation.
- L280-283: It is unclear how you analyzed this? Did you also use LMM?
- Section 2.3: Specify the significance level you used when describing results as statistically significant in the Results section.
- 105 – L286: I believe that *R Studio* is just the interface software allowing you to interact with *R*. Consider citing the *R* version used for analysis instead.

- L297: What is "safe enough"? Isn't that related to the individual's personal risk perception and acceptance?
- Figure 1: Please describe the sub-figures in the caption according to their appearance in the figure. Please name subfigures (a) to (e). This will also allow to refer the reader to sub-figures in the text.
- Figure 1: It seems unusual to mix a figure and a table in a figure. Check with journal guidelines though I suggest to provide the inserted table as a separate table.
- Figure 2: Why does the violin plot in B show values of 0.25 and 0.75? According to the annotation scheme, only values of 0, 0.5, and 1 are possible.
- L313: Please provide a more detailed explanation of what an effect size of 0.21 signifies. Additionally, it would be helpful to clarify which effect size metric you used. As far as I am aware, journal guidelines typically require writing "0.21" instead of ".21".
- L329-334: The abbreviation *M* hasn't been introduced before. Initially, I thought it means *median*, until I realised that it probably stands for *module*. - Please introduce all abbreviations clearly when first used.
- L329-334: What are the values after the *M*, for instance on L334 it says $M_{\text{baseline}} = -0.19$. - How can a proportion correct have negative values? If these are values obtained from the model, clearly say so.
- L335-339: You present findings for competence? What about confidence? Were these two correlated?
- L346/354: Both paragraphs start with "We next investigated..." - is the order of investigation relevant? Consider rephrasing.
- L365: Did you analyze the *kind* of challenges? Or their *number*? If the first is the case, how did you do this?
- Figure 3: what are *average* key learning moments? Doesn't this plot show the number of KLM per participant? How can a participant have 1.5 KLM? Or is this due to the jittering in the plot? Please explain that you are showing mean and confidence intervals (derived from LMM, I presume?). - Overall, I really struggle to interpret this plot. Consider to visualize these results using different ways.
- L555-556: The reference to Green et al. (2022) appears to be misspelled. Elsewhere in the text and in the bibliography, it is listed as Greene et al. (2022).
- L593: I suggest removing "for you" as this seems to imply that backcountry recreationalists is a typical audience reading this publication (which I doubt).
- L610: I suggest removing "A lot!"

- Landrø, M., Hetland, A., Engeset, R. V., and Pfuhl, G.: Avalanche decision-making frameworks: Factors and methods used by experts, *Cold Regions Science and Technology*, 170, 102 897, <https://doi.org/https://doi.org/10.1016/j.coldregions.2019.102897>, 2020.
- Pfeiffer, N. and Foley, J.: Skill and knowledge mastery of students in level 1 avalanche courses, in: *Proceedings International Snow Science Workshop 2006*, Telluride, Colorado, 1–6 Oct 2006, pp. 264–273, <https://arc.lib.montana.edu/snow-science/item/935>, 2006.