Scholarship of Teaching and Learning: Improved learning by peer reviewing field reports

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Abstract

The purpose of this study is to assess the learning effect of introducing a peer review exercise in a fieldwork based bachelor course where the end product is a written scientific report based on the data sampled during fieldwork. The review exercise was designed to accommodate some learning challenges observed over the years the course has been running and consisted of; first an evaluative judgement of an older student report with a similar topic as they had chosen to work with, and second a presentation of the reviewed report to the co-students in class. Afterwards the students were asked to assess how the review exercise met these challenges by a set of eight reflective statements. The reviews were categorized as balanced, neutral or critical based on the given-comments, and the majority of reviews were in the balanced group. The choice of report to review clearly influenced the type of given-comments. The sparse data in this study based on 20 bachelor students, might indicate that reviewers who provided only critical comments didn't necessarily find it easier to start writing their own report afterwards. Regardless of types of comments given, the majority of students felt that the review exercise improved their writing competence and the confidence to start writing their own report. Further findings of the study indicate that the students felt that the review exercise made them motivated and engaged for fieldwork and report work, and made them better prepared for fieldwork. The presentations gave them broad comprehension of the different topics and an increased interest for the other students' topics. More than half of the students found it easier to connect sampled data with lectured theory after doing the review exercise, and felt they had changed an idea they used to have on their subject. The positive feedbacks from the students indicate a gained intrinsic motivation in the students and that they have utilized a high level of cognitive processes during the review exercise. The perception of the experience gained from the review exercise observed by the course responsible corresponded with the findings in the study. According to the course responsible, the average quality of the written reports reflected a higher writing skill and higher-level science in each report than before. The result of this study shows the benefits of introducing peer reviewing in field-based bachelor courses where students have limited experience with fieldwork and in writing scientific reports.

Introduction

As part of the 15 ECTS bachelor-level course "Air-Ice-Sea Interaction I" (AGF-211) at the University Centre in Svalbard (UNIS), the students perform fieldwork on sea ice for eight days where they collect physical data (above, on, in or below sea ice) with different instrumentations introduced in the field. The focus on the course and the fieldwork topics are on the boundary layer interactions i.e. heat-, momentum-, gas- and salt fluxes between atmosphere, sea ice and ocean. Before fieldwork, the students choose their topic from a pre-determined list according to the learning outcomes. In the

field, the students are responsible for the instrumentation and data collection connected to their respective topics, but they are also encouraged to participate on the other students' data collections. After fieldwork, the students analyze their data and relate their analysis to previous and co-students results, and with what they have learned in lectures. The students deliver a first, second and final draft during the report writing process, and get formative one-to-one feedback on each draft from the fieldwork lecturers. The students are invited to the lecturers' offices for feedback discussion. At the end of the course, the students describe their projects and write their findings and conclusions in a scientific report that they have to deliver on a preset deadline. Then they present their results for their co-students and lecturers in class.

Acted as a fieldwork lecturer in AGF-211 for several years, some learning challenges regarding fieldwork and the following report work seem to reappear. The students, most of them never being in the Arctic before, get completely taken up by the environment and being in the field on sea ice for the first time. Understandably for most of them it takes valuable time managing to start focus on their fieldwork tasks, their topics and instrumentations, and especially on the other students' topics. Due to the limited time set aside for fieldwork (approximately one week), this is unfortunate for both their own and the co-students' data sampling. For best results, it is critical to get as much data and as long time series as possible. In addition to their own data sampling, they switch between the other students' data sampling during the fieldwork, so that all students have the opportunity to try all instrumentations and data sampling methods in the different topics, but if not prepared enough mistakes happens and time might run out before getting a full overview of all the activity and tasks on the sea ice. Hence, some students might miss the link between the topics until they start analyze and discuss their own data, and then too late discover that they need input from their co-students to get further with their own analysis. Adding to this, many students seem to have problem getting started with their data analysis and report writing, which in turn give them a very stressful time at the end of the course with little time to discuss and link the topics and relate them with what they have learned in lectures.

As an attempt to address the learning challenges, we introduced a peer review exercise in the course this spring term where the students reviewed a student report by their choice from a previous year covering the same topic that they had chosen to work with. They were told to evaluate the report based on some criteria on how to write a scientific report and then give a grade in the end with a rationale. This was seen as unproblematic since they evaluated older reports with unfamiliar authors. When finished with their review, they presented their chosen report to their co-students in class. According to the self-determination theory (Niemiec and Ryan, 2009), giving the students the perception of having more choices in class or let them experience feelings of autonomy and competence will increase their intrinsic motivation for learning, and by letting the students choose what report to review we wanted to test if the peer review exercise influenced the motivation and engagement for fieldwork and report work. Additionally, we wanted to test if they felt better prepared for fieldwork after evaluating and working critically with good report examples by the students' own choice, and also if they gained more overview and understanding of and interest for their own and the other students' projects both from the review process and the presentations.

A study exploring the learning benefits resulting from producing feedback reviews by Nichol et al. (2014) provides insight into the cognitive processes that are activated when students construct feedback reviews. Their findings show that the process of producing feedback reviews engages the

students in several aspects when evaluating judgement, both about the work of peers, but also about their own work through a reflective process; they both invoke and apply criteria to explain their judgements. Another study on learning by peer reviewing shows that students performing review with rating and comments on peer work improve their writing significantly (Cho and MacArthur, 2011) and support the learning-by-reviewing hypothesis. Further in a study of Cho and Cho (2011) the value of the learning-writing-by-reviewing hypothesis was extended by examining how the type of given-comments improves the reviewer's own writing development and skills. They found that providing weakness comments for micro-meaning (content of writing, i.e. focus, development, validity, and organization, within one paragraph) and strength comments for macro-meaning (content of writing across multiple paragraphs) improved the reviewers' writing skills, but also that reviewers' initial writing skills and the quality of the reviewed peer work influenced the types of given-comments. The peer review exercise in this study is used to examine any learning benefits related to writing competence and confidence. Further, we also want to see how use of good examples as a learning resource can also influence the students' ability to connect sampled data with lectured theory or subjects. Finally, we want to test if the peer-review exercise, but also their own fieldwork and report work, have engaged the students' cognitive processes by asking them if they have changed any ideas they used to have on their subject.

The peer review exercise introduced in the AGF-211 course in spring 2018 is designed to support the students' basic psychological needs for autonomy, competence, and relatedness in the field and during the report writing process afterwards and hence facilitate the students' autonomous self-regulation for learning, academic performance, and well-being (Niemiec and Ryan, 2009). Based on the observed learning challenges and supported by the theories and hypotheses above, the peer review exercise is utilized to test if the students feel

- An improved motivation and engagement for the fieldwork and report work.
- Better prepared for fieldwork.
- A broad comprehension of the different topics.
- A bigger interest for the other students' topics and projects.
- An improved understanding of how to write a scientific report.
- Easier to start writing their reports.
- Easier to connect sampled data with lectured theory or subjects.
- That they have changed any ideas they used to have on their subject.

Method

Having the students taking a stand to some reflective statements related to the peer review exercise described below it was desired to find out if the peer review was helpful in different ways regarding learning outcomes from the fieldwork and report work in the course "Air-Ice-Sea Interaction I" (AGF-211) at the University Centre in Svalbard (UNIS).

The peer review exercise

After the students had chosen their fieldwork topic in the course, and before they left for fieldwork, they were told to choose, read and evaluate a student report from a previous year (available back to 2008) covering the same topic as they had chosen. To give them a feeling of choice and hence

engage their intrinsic motivation (Niemiec and Ryan, 2009), they could choose what annual report to review. Based on some given criteria on how to write a scientific report following a typical order with; 1. Abstract, 2. Introduction, 3. Data, Instruments and Method, 4. Results, 5. Discussion, and 6. Conclusion, they were told to make a one-page peer review including a final assessment and grade. It was clearly stated to the students that the peer review would not affect their final grade in the course. For convenience and also since the students were told to work with previous years reports with unfamiliar authors, it was decided to have named peer reviews. The students hence delivered their peer reviews by email, and were given immediate feedback also by email. Afterwards, they presented the report they had chosen to work with to their fellow students in class. They were given 15 minutes each with 5 minutes for questions in the end.

Assessment of the peer review exercise

To evaluate how this peer review exercise was helpful for the students regarding their fieldwork and report work, they were asked to agree or disagree with a set of eight reflective statements two times during the course (Table 1); first right after the peer review exercise was done and before they left for fieldwork, and then a second time after they had delivered their final report to identify any changes in the students perceptions when thinking back on the cognitive processes utilized in fieldwork and during their report work. The reflective statements were designed to test if the peer review exercise supported the students' basic psychological needs for autonomy, competence, and relatedness in the field and during the report writing process and hence facilitated the students' autonomous self-regulation for learning, academic performance, and well-being (Niemiec and Ryan, 2009). To link the given comments in the peer reviews with the answers to the reflective statements following Cho and Cho (2011) and their findings on how the type of given-comments improves the reviewer's own writing development and skills, it was decided that the students' answers also should be named and therefore delivered by email. It was stressed that the respond to the reflective statements would not affect their final grade in the course. None of the students had any objections to keeping the peer reviews and the answers to the reflective statements named.

Table 1: The reflective statements the students were asked to agree or disagree with, and explain why. The reflective statements were presented for the student two times; first after their peer review exercise and before their fieldwork, and then second after their report work was finished.

	Reflective Statements (Agree/Disagree. Why?)
1	The exercise influenced my motivation and engagement for the fieldwork and report work.
2	The exercise made me better prepared for fieldwork.
3	The presentations gave me a broad comprehension of the different topics.
4	The presentations gave me a bigger interest for the other students' topics and projects.
5	The evaluation and the presentation of the report I chose to work with improved my understanding of how to write a scientific report.
6	It was easier to start writing my own report after the exercise.
7	I find it easier to connect sampled data with lectured theory or subjects after doing this exercise.
8	Have you changed any ideas you used to have on this subject?

Results

The peer reviews and given-comments

The 20 students participating in AGF-211 at UNIS this spring all delivered well-written, constructive and detailed one-page peer reviews of previous years student reports covering the same topics as they had chosen. They all seemed to follow with a varying degree, the provided criteria on how to write a scientific report. Some were well-structured starting with the abstract and continuing section by section to the conclusion, and for each section they first presented the criteria or what to expect before describing how these criteria were fulfilled or not. Others were less structured with more general comments on the content and less on how the criteria for each part were met. A couple was quite short and vague missing some mistakes in their chosen reports, but still with some precise and constructive comments on what they liked and didn't like. Most of the peer reviews were quite positive and well balanced with constructive comments on what to improve afterwards. Sometimes questions were raised to the author, but also suggestions for alternative ways of doing different tasks, both in field and also how to present and analyze data; hence reflecting, relating and thinking forward on their own fieldwork and report work. Some were more neutral and focused mostly on the criteria and content, but still with clear and constructive feedback. Some few were quite critical, only focusing on the negative parts, mostly because of a bad choice of report to work with, but still with suggestions to improvement or descriptions of how they would have done it differently.

All students gave a grade, but not always supported by a summative feedback and rationale. Some of the well-structured peer reviews graded each part and based their final grade on them. Others summarized the comments on the different parts and argued for a final grade. The less structured peer reviews only provided a final grade with no rationale, and sometimes the final grade was not in relation to the type of given-comments.

Looking more closely into the peer reviews three types of comments seem to form;

1) balanced with both positive and critical comments
2) neutral with criteria- and content based comments
3) only critical comments

Most of the peer reviews and corresponding given-comments (14 of 20) fall under the balanced type with both positive and critical, constructive comments. The other two types are equally represented.

The reflective statements

The reflective statements were sent to the students by email two times; the first time just after the peer review exercise and before they went to fieldwork, and the second time after the report work was finished. All students answered once, but the number of students who answered both times was only 17 where 19 students answered the first time and 18 the second time. The results with number of students who *agree*, *disagree*, *partly agree* or *partly disagree* on each reflective statement are listed in Table 2. In addition to the students who left out to respond both times, some students omitted a couple of the statements; hence the number of *no answer* for each statement varies. One student answered *not sure* on a couple of statements on the first response. As seen from Table 2, it is clearly that the majority of students who answered felt that the peer review exercise including the presentation to fellow students was helpful regarding motivation and engagement for fieldwork and

report work (Statement 1), they felt better prepared for fieldwork (Statement 2), they felt they were given a broad comprehension of the different topics in the fieldwork (Statement 3), they felt a bigger interest for the other students' topics and projects (Statement 4), they felt an improved understanding of how to write a scientific report (Statement 5), and they felt that is was easier to start writing their own report after the exercise (Statement 6). They were more divided on Statement 7 where they were asked if they found it easier to connect sampled data with lectured theory or subjects after doing the exercise; interestingly more students agreed on this on the second response after the report work was done. The student who felt unsure on Statements 6 and 7 on the first response partly agreed and agreed with the respective statements on the second response. The majority of students didn't feel that they had changed any ideas they used to have on their subject after doing the peer review exercise and before they went to fieldwork (Statement 8). This changed slightly to more students who felt they had changed their ideas after the report work was finished.

Table 2: Overview of all the students' answers to the reflective statements given the first and second time.

	Reflective Statements							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	First (Second)							
Agree	14 (14)	18 (14)	14 (12)	11 (10)	15 (11)	13 (15)	7 (10)	7 (9)
Partly Agree	2 (0)	1 (3)	2 (2)	3 (4)	0 (2)	2 (1)	1 (1)	0 (0)
Partly Disagree	0 (1)	0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	2 (1)	0 (0)
Disagree	3 (3)	0 (0)	2 (3)	4 (3)	4 (5)	3 (2)	7 (5)	10 (8)
Not Sure	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0)	1 (0)	0 (0)
No answer	1 (2)	1 (2)	2 (3)	2 (3)	1 (2)	1 (2)	2 (3)	3 (3)
Total students	20	20	20	20	20	20	20	20

To identify any changes in the students' perceptions before fieldwork and after their report work was finished, only the students who answered both times were regarded and their answers are listed in Table 3. These students' answers show the same general picture as for the whole student group listed in Table 2. The most significant changes between the first and second time answers on those who agreed were on Statements 2, 5 and 7 followed by Statements 6 and 8. Three fewer students responded *agree* the second time on Statement 2 concerning preparedness for fieldwork, and changed their answers to *partly agree* (two students) and *partly disagree* (one student). On Statement 5, concerning the writing competence, two students changed from *agree* to *partly agree* and one student changed from *agree* to *disagree* the second time. Regarding the connection between sampled data and lectured theory in Statement 7, one student starting from *disagree*, one from *partly disagree* and one from *not sure* changed to *agree* the second time. Two more students answered *agree* the second time on Statements 6, one from *partly agree* and one from *not sure*, hence more students felt more confident in starting writing their own report after the exercise when reflecting back in time on their own report work. On Statement 8 two more students responded *agree* the second time with one from *disagree* and one from *no answer*, hence having changed an idea they used to have on their topic sometime after the first response. One student changed his or her perception from *partly disagree* to *agree* on Statement 1 hence in retrospective thinking that the motivation and engagement for fieldwork and report work was influenced by the peer review exercise. On Statement 3 one less student responded *agree* the second time changing to *disagree*. This student didn't feel any longer that the presentations to the co-students in class gave a broad comprehension of the other students' topics after finishing the report and thinking back in time. Also

on Statement 4 one less student answered *agree* on the second response and changed to *partly agree* when the report work was done, so a bit less convinced that the presentations gave him or her bigger interest for the other students' topics and projects. Another student felt the opposite changing from *disagree* to *partly agree* on Statement 4.

Table 3: Overview of the students' answers to the reflective statements where only students who answered both times are taken into account.

	Reflective Statements							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	First (Second)							
Agree	12 (13)	16 (13)	12 (11)	10 (9)	13 (10)	12 (14)	6 (9)	7 (9)
Partly Agree	2 (0)	1 (3)	2 (2)	2 (4)	0 (2)	2 (1)	1 (1)	0 (0)
Partly Disagree	0 (1)	0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	2 (1)	0 (0)
Disagree	3 (3)	0 (0)	2 (3)	4 (3)	4 (5)	2 (2)	6 (5)	8 (7)
Not Sure	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0)	1 (0)	0 (0)
No answer	0 (0)	0 (0)	1 (1)	1 (1)	0 (0)	0 (0)	1 (1)	2 (1)
Total students	17	17	17	17	17	17	17	17

Discussion

The peer reviews and given-comments

The majority of students (14 of 20) delivered balanced reviews with both positive and critical, constructive comments first addressing what they liked and then pointing out the parts they thought needed improvements based on some writing criteria or content requirements. Three students made reviews with more neutral comments based on writing criteria and content requirements without praising or criticizing, only stating what was wrong and what needed improvements with suggestions to solutions. Three students produced very critical reviews only focusing on what they didn't like and what was wrong according to the writing criteria and content requirements. This was mostly due to unsatisfactory preparatory work with choosing an older report leading to a bad choice of report to work with. According to Cho and Cho (2011), the reviewers' initial writing skills and the quality of reviewed peer drafts influence the types of comments given. The importance of the choice of report should be more clearly stated next time introducing the exercise; that the older reports are of varying quality and that the students should make sure to choose one of good quality.

Cho and Cho (2011) found that providing critical comments for writing content (focus, development, validity, and organization) within a section and positive comments for writing content across multiple sections improve the reviewers' writing qualities. In this study, we use the students' feelings about their own writing process after doing the review exercise as a measure. As an attempt to find any connection between types of given-comments as categorized in this study (balanced, neutral, or critical) and answers to the reflective statements (*agree*, *disagree*, *partly agree*, or *partly disagree*), the answers were linked to the corresponding reviews and categories. The results showed that all the students providing neutral (3 students) and critical (3 students) comments answered *agree* with Statement 5 and felt the review exercise improved their understanding of how to write a scientific report. Four of the students who made more balanced reviews answered *disagree* with this and the rationale was that they already knew how to write a scientific report because they had written a couple of reports already. On Statement 6 where the students were asked if it was easier to start

writing their own report after the exercise, those who provided neutral comments answered *agree* both times. Of the students who made critical comments one answered *agree* and two answered *disagree* first, and then one of them changed to *agree* the second time. Only one student (of 14 students) who delivered balanced comments answered *disagree*, the others agreed and found it easier to start writing their own report after the peer review exercise. Those who disagreed on Statement 6 explained that they would have read earlier reports anyway to find good examples to help them get started, or they meant that practice yourself is the best way to learn. Based on our limited amount of data, it is hard to draw any conclusions on the link between given-comments and how they affect the writing skills of the reviewers. Using our goodwill, our sparse data might indicate that reviewers who provide critical comments don't necessarily find it easier to start writing their own report. Otherwise, most students regardless of types of comments given, found that the review exercise improved their writing competence and their confidence in starting writing their own report after doing the review exercise. The positive feedbacks from the reviewers concerning their feelings about their own writing process after doing the review exercise will encourage us to introduce this exercise in other fieldwork courses at UNIS. This will provide more data to work with and probably more statistically reliable results regarding the types of comments given.

The reflective statements

The reason to introduce the peer review exercise in the bachelor course AGF-211 at UNIS this spring term was to stimulate their focus and intrinsic motivation for learning, help the students to feel better prepared and competent for their tasks during fieldwork, give them an overview of the other students' topics facilitating the feeling of relatedness with their own topic, help reduce any uncertainties towards writing which might hinder them from starting writing, and enable them to bridge the gap between knowing the theory and concepts taught in the course to applying that knowledge to explain their data collected in the field. A set of eight reflective statements were designed to assess the peer review exercise (Table 1). The first and second time answers on the reflective statements sent to the students by email, were analyzed and assessed to find how many who agreed or disagreed with each statement (Table 2). The numbers listed in Table 2 will be regarded as a measure of the usefulness of the review exercise to reduce the observed learning challenges in the course by facilitating the students' self-regulation for learning, academic performance, and well-being during the fieldwork and during their process with the report work.

Engagement and motivation for fieldwork and report work

As seen from Table 2, most of the students felt that the review exercise influenced their motivation and engagement for the fieldwork and report work (Statement 1). A typical explanation was that the review exercise forced them to get involved in the study of previous reports and hence got them into their subject with some sort of overview and comprehension of what they would be doing, why they are doing it, what did or didn't work, and what could be exciting to try out. One student claimed that having a good understanding of what was done out in the field was necessary to make the fieldwork and report work engaging. Another student who agreed wrote that reading through the report in so much detail made her more interested in the topic. One answered that the exercise gave him a better understanding of the connections of the different topics, but also between the theory and the fieldwork. Another one wrote that she got more insight in the task and that it was a natural way to read up on the material. She got motivated to investigate the subject more in-depth, and also thought about how she wanted to write her own report while doing the review exercise. Most of

those who disagreed with Statement 1 wrote that they already were motivated and engaged for fieldwork and report work and that the review exercise didn't influence this. One student who disagreed commented that he would prefer a short introduction of method, scientific question and goal of experiment before the fieldwork instead of the review exercise due to the time limit. Another student who disagreed ended up doing a different experiment. The last student who disagreed wrote that performing fieldwork himself and talking with fellow students and supervisors motivated and engaged him most.

Statement 2 regarding preparedness to fieldwork was the statement most students agreed with (see Table 2), and the following are typical comments from this group of students:

"I agree, because I had to explain to my fellow students the precise flow of each measurement. I prepared my experimentations."

"I now have a decent understanding of the methods and instruments that I'll have to use aboard and on the sea ice. It is always beneficial to know what the context is, what the instruments are and what the theory behind the subject is before going to fieldwork."

"I would not have thought so much about how I would conduct fieldwork without it. I will probably feel more comfortable about what I am doing in the field. Thinking about what to do exactly during fieldwork can avoid some mistakes and save time."

"Yes, because I thought about the topic when I was reading the report. And also I found useful tips on how to conduct the measurements in the report and I can now avoid making some mistakes."

"Yes, we knew who had a close subject to ours and every day before going into the field, we could discuss with them so that we have easily shared data."

"Reading the old reports and preparing a presentation for the current course led to a more intensive dealing with my own topic. I became aware of a lot of difficulties I had to expect during fieldwork."

"Through the exercise I have imagined my experiment protocol or I would say that I have discovered it through the report. After I have made my arrangements and write my own. And once again at the end of the exercise I have read it again, improve it and make a template and instructions for my cruise experiment. I have also read several reports which allow me to discover different experiments which I have chosen to reproduce or not. So I had expectations before the fieldwork on how it will be during the experiment and as always you have to adapt to the conditions and be prepared allow you to better answer to the encountered problems."

From these comments it can be concluded that the review exercise clearly stimulated the students' cognitive processes. They were thinking about their own experiment while evaluating the older reports. Getting an overview of their instruments and methods made them feel more confident and competent doing fieldwork. Some students also imagined how to conduct their experiments in a new way based on their review on older reports where they learned and judged what was working and not. The presentations gave some of the students the knowledge of what data they needed from others and motivated them to cooperate in the field and share data. The one student who partly disagreed on Statement 2 commented that *"the exercises indeed added a bit of help for the fieldwork but I rather support the idea of having addressed the fieldwork way earlier in the lectures, making the*

latter explicitly revolve around what will later be dealt with on the field". Those who partly agreed wrote that they ended up doing a different exercise or that the fieldwork was not relevant for their topic.

Comprehension and interest of the other students topics

On Statement 3 and 4 also the majority of students agreed and felt that they got a broad comprehension of the different topics and a bigger interest for their co-students' topics and projects. The degree of comprehension and triggered interest depended on the quality of the presentations; some presentations were of high quality going through the aim of the study, the instruments and methods, the theory behind it, the data analysis and results with discussions of what the reviewers found important, and what did work and not. One student claimed that without the presentations she would most likely not have studied the other students' topics. One student who agreed with both statements wrote that she after the presentations had a better understanding of what the others would do, especially because some subjects were not really clear for her before. She also felt more interested in the other subjects and was given the opportunity to see where to collaborate with the others. Those presentations that mostly focused on the evaluation and judgement of the writing content in the report they had chosen to work with didn't provide the co-students with a bigger comprehension of these topics and the interest for them was not triggered. One student who disagreed with Statement 3 wrote that the presentations weren't clear enough to offer the best understanding of the different topics at that stage; he thought that they were valuable mostly for the presenting students themselves, as an exercise of introspection into their own understanding. As a comment to Statement 4 where he partly agreed, he thought that the presentations brought curiosity, but didn't either provide enough information to understand the potential link between the different experiments nor supported autonomous thinking around the topics, which as he states *"yet is the best indicator for someone's interest"*. One student who disagreed with Statement 4 commented: "*Disagree, my interest hasn't yet changed. I know it will the more I talk with them on the boat, connect their works with mine, think about the broader picture, synergize with them in the data-processing, etc.*" Others who disagreed with Statement 4 wrote that they already were interested. Regardless of the quality of presentations, some students wrote that they only got into their own subjects and didn't get interested in the other students projects. When introducing the exercise, some misunderstandings aroused around how the form and content of the presentations should be like, so to optimise this part of the exercise in the future this needs to be stated more clearly.

Writing competence and confidence

Also on Statement 5 concerning the improved understanding of how to write a scientific report, most students agreed that the peer review exercise was helpful in this regard (Table 2). The rationales were quite positive, and some students mentioned that it was helpful because they had to rate a previous report. This is in contrast to earlier findings suggesting that students do not learn much from simply grading peer work (Sadler and Good, 2006) or are uncomfortable about being assessed by peer and that they have reservations about the fairness and accuracy of such processes (Liu and Carless, 2006; Kaufman and Schunn, 2011). In this study, the peer reviews were on previous student reports with unknown authors, which probably made it easier to make honest and fair peer reviews without being concerned about the authors' feelings. One student wrote that writing the evaluation made him think critically and helped to get a more objective look at the report and to see things that

you may not see when writing your own report. Another student who agreed wrote that due to his limited experience with scientific reports, he clearly learned a lot about the structure of scientific reports when writing the review. One claimed that the review exercise really made her think about which parts are important to highlight and develop in a paper. Another who agreed commented: *"Agree, because I had to put more into how such a report should be written to write a proper feedback. I became aware of what was working and not working."* Others who agreed thought that the review exercise was an efficient way to work out the most important aspects of a scientific report, and that it allowed them to understand the expectations of a scientific report to try to avoid some mistakes. For these students the review exercise activated cognitive processes and made them think about how they should write their own report while making evaluating judgement of an earlier report. Like one student commented: *"Reading old reports with the report guidelines in mind helped me detecting potential errors and difficulties, also for my own upcoming report."* The audience effect research emphasizes the importance of understanding readers' perspectives, and a couple of students specifically commented that the exercise made it clearer for them how to structure the report in a way that made it comprehensible and clearer to the reader. They though it was interesting to see it from the "other" side. Cho and MacArthur (2011) suggested that enhancing writers' understanding of the readers' perspectives and needs is one way in which peer reviewing can lead to better writing. Those students who disagreed with Statement 5 had already written scientific reports and were already quite familiar with how to write it, or they had chosen a bad report to work with. In the future when introducing the review exercise in a course, it should hence be clearly stated the importance of choosing a good report to work with to optimise the exercise.

Most students found it easier to start writing their own report after doing the review exercise and agreed with Statement 6 (Table 2). The rationales for this were often linked to Statement 5; it was easier to start writing, because they started to think about their own reports much earlier, they knew what to expect, they knew the material better after critical judgement of the older reports, they had acquired some thoughts of what to write about and how to do it, they felt that they had been provided a good starting point and guide to what kind of structure that worked well, they had gotten a good overview of their subjects, and they had acquired ideas on how to use the data. Following are examples of comments from students who agreed:

"Agreed. Without a shadow of a doubt. I now know what makes a report thorough and pleasant to read, it will therefore be much easier for me to write my own report."

"Agree. Because I have already developed a theoretical knowledge about my subject and a way to present my results which I can judge bad or good and improve or not."

"I had an idea of how I wanted my report to be written to ensure that I understood it completely myself and that others could get something out of reading my report as well."

One student who partly agreed wrote that it helped to start work on the results, but not that much for the writing. Another student commented that she would have read older reports anyway to help her start writing regardless of the review exercise. A third student answered that the exercise would prevent them from making basic mistakes, but that starting writing is still complicated and only practice can help. Those who disagreed with Statement 6 didn't feel that the exercise made any difference, and as for Statement 5 a bad choice of report was the reason for this.

Connecting data with lectured theory or subjects

As seen in Table 2 the students were more divided on Statement 7 concerning the gap between knowing the mathematical equations and theory taught in lectures to applying that knowledge to explain what they see in their data collected in the field. One of the aims of the review exercise was to try to bridge this gap by letting the students evaluate judgement of older reports with similar topics or subjects, but of course with other data, and through this cognitive process get ideas to why and how to analyse data, recognize any trend in data, and link these to the theory behind their chosen topic, in addition to compare and discuss their data against older reports and data. One student who agreed with Statement 7 commented that during the preparation of the exercise he had to understand the meaning of the data using theoretical material and scientific literature. Another student wrote that by hearing the others' presentations she realised which datasets she might be able to use for her own project. One student commented: *"Agree, a good theoretical background meant that the experiments were well planned, which details were important to be vigilant about etc."* Another student answered: *"Yes. It's always good to have the theory in mind when one collects data. Preparing the presentation made me think about the theory and the data analysis."* Another student who agreed wrote: *"Yes, thank to this exercise, we had a better understanding of the theory and the different phenomenon we then studied and we were more able to connect the physical measurements with the theory."* Those who disagreed with Statement 7 commented that; the exercise didn't went deep enough into the subjects to make them able to see the connections to their data, it depended on the report where some had chosen one of poor quality that didn't link data to lectured theory or subjects, they had mostly focused on criteria and not content when doing the review exercise, they would have looked at older reports to get ideas regardless of the review exercise. One student commented that he found it far easier to connect sampled data with lectured theory after the fieldwork and after writing his own report than after the review exercise. These points to the importance of letting the student actively work with the data themselves to let them find the connections to mathematical equations and concepts taught in the course. The findings in a study of Baddeley (2016) indicated that students who were engaged in active learning methods in a one-week interactive workshop analysing computer based data, improved their understanding of how to utilize their knowledge of physics when interpreting and understanding data. They felt they also gained an insight into the methodology utilized by scientists when interpreting data, in addition to a higher level of enthusiasm and interest. The benefits of applying interactive teaching methods when introducing students to data analysis should be better utilized in the future.

Change of perceptions and ideas

The answers from the students, who answered both times (Table 3), show that most students did not change their perception of how the review exercise was helpful in the areas presented in the reflective statements in Table 1 (Statements 1 to 7). The few students who changed their perceptions the second time generally felt more convinced that the review exercise was helpful after they had finished their report except for preparedness for fieldwork (Statement 2), their comprehension of the different topics (Statement 3), their interest for the other students' topics (Statement 4), and their understanding of how to write a scientific report (Statement 5). Those who have a negative change doesn't provide any clear rationale, but typically commenting that the report they chose to work with didn't touch upon the content they needed or were of bad quality, or that they ended up doing something different in the field, or that the fieldwork was not relevant for their topic. Some wrote that they didn't get a broad comprehension of all the other students' topics, because it

depended on the presentations and what they focused on; content or criteria. The students who felt a positive change in perception of the review exercise felt that, after doing the fieldwork and report writing and thinking back in time, the exercise made them more motivated and engaged for the fieldwork and report work (Statement 1), it was easier to start writing their own report (Statement 6), and it was easier to connect sampled data with lectured theory (Statement 7). It should be mentioned that these results on changes are based on a small group of students and are hence not significant. Further studies in future field courses should be conducted to ensure more data. Regardless of the changes in perceptions, the results show that the majority of student found the review exercise helpful in all the areas presented in the reflective statements.

Another positive outcome of the first and second time answers to the reflective statements is that more students felt that they had changed ideas they used to have on the subject after doing the fieldwork and report writing (Statement 8). The following shows typical comments on Statement 8:

"Agree; my deeper understanding of the subject has changed my ideas on it as well."

"Yes, I understand now the complexity of measuring density and the viability of each measurement. Sea-ice density is not easy to measure."

"After the report writing and research I think oceanography and sea ice are more exciting than I had believed. It's a very exciting field, and maybe I would like to work with it in the future."

"Working intensely on a sea ice topic did indeed change my ideas that I had about it."

"I have gotten several ideas that I can explore."

"Yes, I really enjoyed the fieldwork, seeing applied what was written earlier in the report (although not very extensive), and being able afterwards to write myself on the topic."

"Yes, I extended the scope of the work due to the different report content of the previous years."

"Yes, I did not see the point of this presentation before doing it but now, everything is clearer and I really think that it was a good thing to do before the fieldwork."

"Yes, I thought that the gas content would be much easier to measure! We criticize a lot the method in our report and this was probably missing in previous reports. So that next year, students will be more aware of the process and will maybe offer something new to improve it."

Those who disagreed with Statement 8 typically answered that they didn't know much about the subject before the report writing and hence had no preconceived ideas about it. Most of what they knew when answering was a direct result of the fieldwork and report work. Others commented that they didn't necessarily had any changed ideas due to the review exercise, but rather more thoughts about the subject.

The positive comments from the students highlight excitement for the fieldwork and subject, deeper acquired understanding of the subject, gained insight into the careful methodology of sampling reliable data in the field, the need to describe these and the error sources properly in the report to accommodate the readers' perspectives, and an emergence of new ideas they would like to explore further. These are very positive feedbacks indicating a gained intrinsic motivation in the students and

that they have utilized a high level of cognitive processes during the review exercise. Doing peer review not only results in students gaining a deeper insight into subject matter, but as importantly stated by Nicol et al. (2014): *"crucially, it will also enable them to acquire skills which are currently not explicitly developed through the curriculum, even though they constitute an important requirement in professional life beyond university. These skills include the ability to engage with and take ownership of evaluation criteria, to make informed judgements about the quality of the work of others, to formulate and articulate these judgments in written form and, fundamentally, the ability to evaluate and improve one's own work based on these processes."* This encourages a continuation of the review exercise in the course AGF-211, and an introduction of it will be done in other field courses at UNIS (i.e. in the bachelor course "Polar Ocean Climate, AGF-214).

Conclusions and future work

The review exercise introduced in the bachelor course "Air-Ice-Sea Interaction I" (AGF-211) at UNIS this spring term seemed to be a success judging from the students assessments of it. The review exercise was designed to meet some observed learning challenges over the years the course has been running, and the students were asked to assess afterwards how this review exercise met these challenges by a set of eight reflective statements. Their reviews were on older student reports with a similar topic as they had chosen and consisted of an evaluation part where they commented what they liked and didn't like based on some given criteria on how to write a scientific report with a final grade and a rationale in the end. Then they had a presentation part where they presented the reviewed report for the co-students in class. Because the reviews were on older reports with unfamiliar authors, both the reviews and the answers to the reflective statements were named to make it easier to link them. The reviews were categorized as balanced, neutral or critical based on the given-comments, and the majority of reviews were in the balanced group. The choice of report clearly influenced the type of given-comments. Those who produced very critical reviews did so due to a bad choice of report to work with, which should be avoided since studies indicate that to improve reviewers' writing qualities optimally they should provide balanced comments with critical comments on writing content within a section and positive comments on writing content across multiple sections. Based on our limited amount of data, it was hard to draw any conclusions on the link between given-comments and how they affected the writing skills of the reviewers. The sparse data in this study might indicate that reviewers who provided only critical comments didn't necessarily find it easier to start writing their own report afterwards. Otherwise, most students regardless of types of comments given, found that the review exercise improved their understanding of how to write a scientific report, and they found it easier to start writing their own report after doing the review exercise. The comments on the reflective statements also showed that the majority of students felt that the review exercise influenced their motivation and engagement for fieldwork and report work, and made them better prepared for fieldwork. The presentations gave them a broad comprehension of the different topics and a bigger interest for the other students' topics depending on the content of the presentations and the enthusiasms of the presenters. Less convincing, but still supported by more than half of the students, they found it easier to connect sampled data with lectured theory after doing the review exercise where they had to actively involve themselves in understanding the data sampling and analysis and the theory behind it to be able to make evaluative judgement of others work in a similar topic, but with different data. As a final test of the learning outcome of the review exercise, the students were asked if they had changed any ideas

they used to have on the their subject, and also more than half of the students answered yes to this, and even more the second time after finishing the report writing. Those who didn't, hadn't had any preconceived ideas about the subject before the review exercise or the course.

The positive comments from the students indicate a gained intrinsic motivation in the students and that they have utilized a high level of cognitive processes during the review exercise. This corresponds with the perception of the experience gained from the review exercise given by the course responsible in Appendix A. He concludes that the effort carried out in this years' course clearly showed improved performance and increased motivation by the students before, during and after fieldwork. The review process and the presentation of the report they had chosen to work with clearly made the students more aware of their task and the connection to other tasks. During fieldwork, the students immediately knew what to do and started their fieldwork assignments without much supervision. They had also prepared routines for collecting data and how to best conduct their fieldwork in order to get the most suitable data collection. The students felt that they "owned" their own project and data collection, which made it much easier for them to start their report writing. The course responsible could clearly see that the students were highly motivated to get results and compare it with other students' results. The review process where they evaluated a former report up against a template for how to write a scientific report, made it easier for them to start writing their own and less supervision on formal writing format was needed. This made it easier for the students to present their results in class in a structured manner and to compare it to other results. The course responsible concludes in his comments that the average quality of the reports reflected a higher writing skill and higher-level science in each report, and that he will make this review exercise a permanent module of the AGF-211 course.

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Appendix A: Comments from the course responsible on the experience gained from the review exercise

As the course responsible for the course where the students were conducting the review exercise, AGF-211 "Air-Ice-Sea Interaction I", I can conclude that the effort carried out in this years' course clearly showed improved performance and increased motivations by the students before, during and after the fieldwork. I will make this exercise a permanent module of my course.

After selecting a topic from a list of fieldwork assignments, the student search through all the former reports to find a report on a similar topic that they would review. The review process and the presentation of the report clearly made the students more aware of their task and the connection to other tasks. This could be monitored by seeing how they prepared their field assignments and measurements, and how they realized what they needed as input and measurements from other field tasks. They could also prepare a list of equipment needed for their fieldwork and were able to prepare and pack their instruments before departure for fieldwork. All these aspects have not been possible before due to the lack of pre-knowledge of their fieldwork task and procedures.

During fieldwork, the students immediately knew what to do and started their fieldwork assignments without much supervision. Only technical support and setup of advanced instrumentation were needed. They had also prepared routines for collecting data and how to best conduct their fieldwork in order to get the most suitable data collection. Again, this has never been possible with the old course routines. Before, the teachers would need to help each individual task to start and this would basically be the first really experience with the instruments and fieldwork procedures.

Since the students now felt that they "owned" their own project and data collection it made it much easier to start their report writing and we could clearly see that they were highly motivated to get results and compare it with other students' results. Furthermore, due to their review process where they evaluated former report up against a template for how to write a scientific report, it was easier for them to start and less supervision on formal writing format was needed. This made it easier for them to present their results in class in a structured manner and to compare it to other results. The average quality of the reports reflected a higher writing skill and higher-level science in each report.

Prof. Frank Nilsen

AGF-211 course responsible