How to make virtual field guides, and use them to bridge field- and classroom teaching

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Abstract: At the University Centre in Svalbard (UNIS), fieldwork is an important part of all courses, but the transition from theory in the classroom to the arctic reality is a challenge. Other common challenges with course-related fieldwork are insufficient preparation, no possibilities to revisit a location to repeat difficult issues or resolve misunderstandings, and lack of suitable assessment methods of field-related learning outcomes. To narrow the gap between theory and practice and improve the alignment between field-related learning outcomes, activities, and assessment, we created a set of virtual field guides (VFG) from different locations in Svalbard based on 360-Degrees photographs collected during summer 2019. The VFGs were intended for use in combination with fieldwork in terrestrial biology courses the following years. Due to COVID-19, all courses were cancelled in 2020, and UNIS had reduced activity in 2021. The VFGs were therefore tested and evaluated by former students that had visited the locations the VFGs represented, but had not used VFGs as an integrated tool to prepare their field course. Evaluation data were collected through an anonymous survey. Eight of 16 students responded. We also collected experiences from arranging a post-fieldwork learning activity (16 students) that required knowledge of "reading landscapes," a typical field skill. The current feedback indicates that VFGs provide students with a more realistic picture of what awaits them in the field, and aid preparing, planning, and recapitulation activities of fieldwork, but cannot substitute for fieldwork. However, VFGs can be used to practice and assess certain field-related skills. The learning potential in fieldwork is huge, but rarely fully utilized. We provide a "how to" guide for making VFGs, and argue that these rather simple digital tools improve field learning and better utilization of investments in field activities.

1 Introduction

1.1 Learning through fieldwork and constructive alignment

Fieldwork is an important and highly appreciated learning activity in many disciplines, and enables training of practical skills and possibilities to reinforce content knowledge in multifaceted and authentic settings (Fuller et al., 2014; Harland et al., 2006; Kent et al., 1997; Lisowski & Disinger, 1991; Lonergan & Andresen, 1988). This complexity is also challenging. From a teacher's point of view, fieldwork is an opportunity to give students hands-on experience with a range of exciting phenomena, and every minute of the costly field time should be utilized (Eidesen et al., 2017). On the other hand, the well of new experiences (and distractions) may overwhelm students and make it difficult to focus (Lonergan & Andresen, 1988).

To succeed, field activities need good planning and preparation, and proper debriefing and evaluation (Eidesen et al., 2017; Kent et al., 1997; Lonergan & Andresen, 1988). Thus, we should plan fieldwork as we plan courses—according to the principle of constructive alignment (Biggs & Tang, 2011). That is, we achieve better learning by identifying what we want our students to learn through defined, justifiable learning outcomes, and then align activities and assessment towards our defined learning outcomes (Biggs & Tang, 2011).

1.2 Potential for improvement

In the case of field activities, we tend to neglect the importance of preparation, post-field recapitulation activities (including repetition, theory-connections, and reflection) and assessment (Eidesen et al., 2017; Lonergan & Andresen,1988)(Eidesen et al., 2017; Lonergan & Andresen, 1988). This was shown in an internal case-study at The University Centre in Svalbard (UNIS), focusing on the potential for improvement of field activities (Eidesen et al., 2017). The authors revealed that fieldwork, despite being highly appreciated by students (The University Centre in Svalbard, 2010, 2020), often lacked proper preparation, debriefing, and assessment of learning goals (Eidesen et al., 2017). Time constraints were often the reason for deprioritizing briefing and debriefing activities. Further, many intended learning outcomes related to field activities at UNIS (such as practical field skills, or general competences such as teamwork) were never part of any direct assessment – it was just assumed that students acquired practical skills and competences by joining field activities (Eidesen et al., 2017). Similar misalignment between practical learning outcomes and assessment have also been reported for other practical learning activities such as laboratory exercises (Adams, 2020) and work practice (Ajjawi et al., 2020).

To improve alignment related to practical learning activities like fieldwork, efficient ways of doing preparation- and post-field activities are clearly required (Eidesen et al., 2017). In addition, we need to develop and test alternative ways of assessment targeted towards intended learning outcomes related to skills and competences. We decided to search for solutions in our fast-growing digital toolbox.

1.3 Virtual Field Guides as digital bridges to improve fieldwork

Combining real-world experiences with various levels of virtual reality (VR) or augmented reality (AR) in educational settings is common in several disciplines (Cliffe, 2017; Hamilton et al., 2020; Hoffmann et al., 2014), and shown to be an efficient way to meet some of these challenges, for example improved preparation for fieldwork (Cliffe, 2017). What type of virtual elements to use depends on a combination of your budget, available technologies, the affordances they provide, and the learning outcomes you hope to achieve (Cliffe, 2017; Dolphin et al., 2019; Fowler, 2015; Litherland & Stott, 2012).

In this study, we aimed at finding a digital tool for improving preparation, post-field debriefing activities and assessment of fieldwork related to arctic biology at UNIS. It was important that the tool should not require too much expertise to develop and be possible to use by the students before arriving to the field site. Thus, there should not be a need for additional equipment besides a computer and on-line access. We therefore decided to explore the use of rather simple virtual field guides (VFGs) that try to capture the real world environment of a specific location or region through various digitalized elements, aiming at improving rather than replacing traditional fieldwork (Cliffe (2017) and references therein). Thus, we did not aim to provide a fully immersed environment where you need additional equipment such as VR-headsets, but rather we created 360-Degree tours around Svalbard containing relevant information for the specific locations.

We started our project in 2019, pre-COVID, and the initial plan was to test and develop VFGs in close cooperation with students and staff in several courses that emphasise fieldwork. The level of emergency preparedness in Svalbard was not scaled to tackle a COVID outbreak, and as a result all courses at UNIS was cancelled autumn 2020, and run with reduced capacity and fewer field activities in 2021. Thus, after development, we have had reduced possibilities to test the VFGs in preparation for fieldwork.

1.4 Objectives

In this paper, we present 1) how we made VFGs (360-degree tours) from a set of locations in Svalbard and how you can make your own, 2) feedback from students testing the VFGs, 3) an example of a post-field recapitulation activity with focus on repetition and transferability of acquired knowledge and skills using VFGs, and 4) a discussion of our current results, including a reflection on how to expand the use of VFGs to improve constructive alignment towards field-related learning outcomes.

2 Methods

Note to reader: If you read this methods section with the aim of making your own VFGs, we suggest visiting www.learningarcticbiology.info before diving into the detailed description provided in the *Appendix*.

2.1 Making Virtual Field Guides - VFGs

Most pictures were collected during course fieldwork at UNIS in summer 2019. The visited locations were chosen to cover a wide variety of vegetation types, with contrasting biological-, geological- and climatic conditions affecting vegetation.

360-degree photographs were taken at regular intervals moving across the landscape using a 360-degree camera, in our case a Insta360 ONE X, and built into virtual field guides using the software PANO2VR and Adobe Photoshop. Coordinates, habitat descriptions and additional footage were collected in connection with each picture. The VFGs were made available online through a webpage in WordPress (https://learningarcticbiology.info/360/vfg/map/). Detailed description of how to make a VFG is provided in the *Appendix*. During the development phase, the VFGs were tested by a paid panel of four students that provided feedback on a demo version.
In our case, the initial investment in equipment was about 10 000 NOK (including camera, GPS, tripod, a power-bank and software). Time investment in learning to use the camera, software and photo handling was done during a single day of practicing and doing a test shoot. The full VFGs with additional information embedded require a time investment of around two work-weeks (minimum), whereas the simpler, purely observational 360-degree tours required about 2 to 3 workdays (see *Appendix* 6.6 for details).

2.2 Testing VFGs on former students

The initial plan was to test the VFGs during courses in 2020, but all relevant courses were cancelled. As an alternative, we invited former students to test the VFGs. In April 2021, we sent an invitation to 16 former students participating in a relevant field course during summer 2019. They were invited to explore at least two VFGs and answer a voluntary, anonymous, electronic survey created with nettskjema.no, survey solution developed and hosted by the University of Oslo (nettskjema@usit.uio.no). The survey constituted of two open questions and 32 statements. The students were asked to rank the statements following a five-level Likert scale: 1 - Fully disagree, 2 – Disagree, 3 – Neutral, 4 – Agree, 5 – Fully agree (*Appendix* 6.7). The questions aimed at probing four aspects: 1) their learning experience with using VFGs to revisit field locations they had visited physically in 2019, 2) their opinion (in retro-respect) regarding the usefulness of VFGs for preparation for fieldwork, 3) their general impression of the usefulness of VFGs, and 4) the user experience with the web user interface/technical solution. The survey was open for two weeks. Data from the survey were summarized and plotted with the Likert function included in the HH v.3.1 package run in R v 4.0.3 (Heiberger, 2020; R Core Team, 2020).

2.3 Testing VFGs as part of a learning activity utilizing field-acquired knowledge and skills

In October 2021, as part of training 16 bachelor students in vegetation ecology, we designed a learning activity using VFGs to re-activate field skills. The fieldwork they had attended physically should have provided these students with certain skills of "reading landscapes." The learning activity aimed at activating these skills. The learning activity was designed as a case study, where the students pretended they worked as environmental advisors for the local authorities. The case described a scenario where students had to evaluate an application from a local tourist company that wanted to build cabins in four different locations in Svalbard. These four locations were unfortunately also candidates for new nature reserves. The students worked in groups (three or four together). The students were provided a table with some additional information about each location, such as number of registered red-listed species, and a link to the VFG from each location (Table 1). The students had visited similar locations during fieldwork in August 2021, but they had not visited the exact locations these VFGs represented. They were asked to search for certain information in the VFG, and evaluate features with the landscape they observed, and incorporate knowledge on how vulnerable they thought the different landscapes would become if climatic factors such as temperature and precipitation changed. They worked with the task for about an hour, and at the end, each group revealed their final decision simultaneously. Then we discussed the rationale behind each group's decision.

One of the authors was leading the session, whereas the other was observing the activity and how the students were working with the VFGs. Feedback from students about the session was provided orally immediately after the learning activity.

Table 1. *Part of the data matrix used in a case-study exercise to practice acquired field-skills. The students compared virtual field guides (VFGs) from four different locations. The task was to "read the landscape" and combine this knowledge with additional information provided in the table and the backstory of the case study (one page text). The original data matrix also contained information on genetic variability within populations of a fictive endemic species that was part of the backstory. Species numbers from https://artsdatabanken.no/ October 2021. Red List rating: NT- Near Threatened; VU – Vulnerable; EN -Endangered; CE-Critically Endangered*

Location	Kapp Nathorst	Hemsedalen and Flintholmen	Calypsostranda	Midtrehuken
Link to VFG: learningarcticbiology.info/360/vfg/map/	kapp-nathorst/	hemsedalen/	calypsostranda/	midterhuken/
Total no. of registered vascular plant species	67	61	49	71
Registered bird species (sighting – not number of breeding, many single registrations of, e.g., red-listed species)	5	22	12	27
Number of red listed plant species recorded.	6-NT	4-NT, 1-EN	3-NT	4 NT
Number of red listed bird species recorded	2-NT	6-NT, 3-VU, 1-EN	3-NT	7-NT, 2-VU, 1-EN
Level of habitat variation - use VFGs and fill in				
Bedrock – check locality information in VFG and fill in				
Bioclimatic zone – check locality information in VFG and fill in				
Likely changes with warmer climate?				
Likely changes with higher precipitation?				

3 Results

3.1 Available VFGs (as of September 2024)

At present, 18 VFGs have been developed and published within this project. In addition, we have published some 360-picture taken from marine sites and two miniVFGs of the research town Ny-Ålesund and the old mining settlement Svea (with fewer pictures and less additional information). VFGs are available at https://learningarcticbiology.info/360/vfg/map/ (Figure 1).

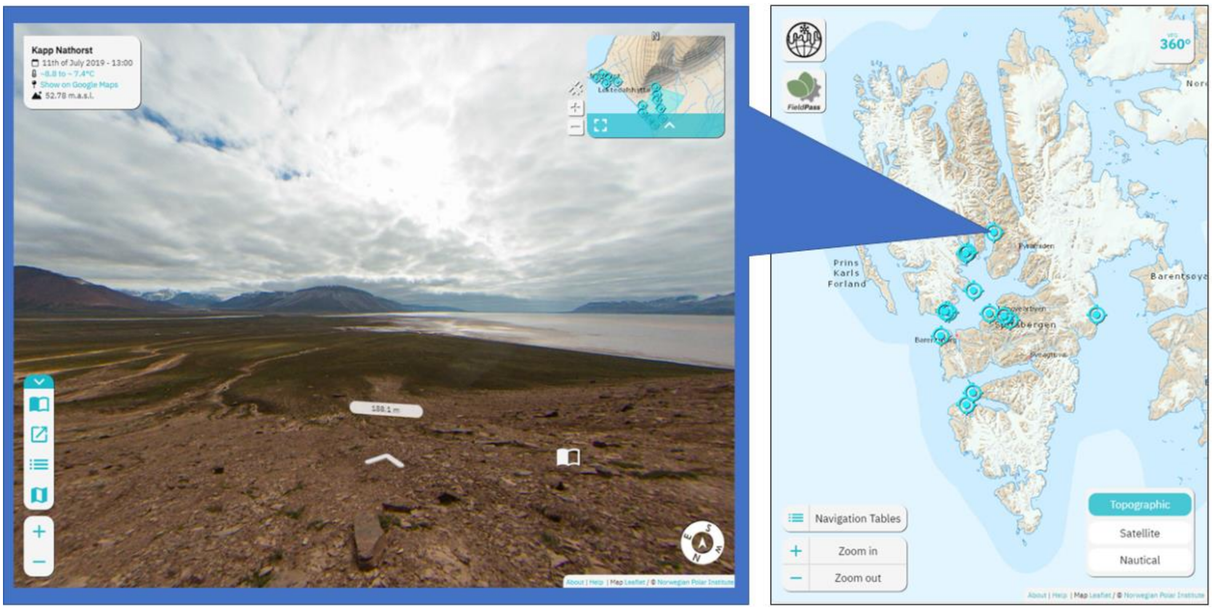

Figure 1. *Virtual Field Guide from Kapp Nathorst, Svalbard*

3.2 Feedback from former students

Eight of 16 students responded to the survey. Those that responded found VFGs helpful for repetition, and they felt a sense of recognition. Some students reported learning something new when revisiting locations through VFGs (Figure 2). When asked about potentials (in retrospect) related to the use of VFGs in preparation of fieldwork, they reported that VFGs would make it easier to plan for fieldwork, and make expectations for field work more realistic. Some also expected an increased learning outcome. They regarded VFGs as good tool to combine with field teaching, although VFGs should not be used as a replacement for field work (Figure 2). Through open comments, students suggested we add seasonal variation.

Most students that tested the VFGs found them relatively easy to navigate, but most students found the amount of information too brief. Some found the VFGs difficult to navigate, which also was echoed in the open comments. The students showed no appreciation for content that they actively had to search for, such as information boxes that were not listed in the explorer.

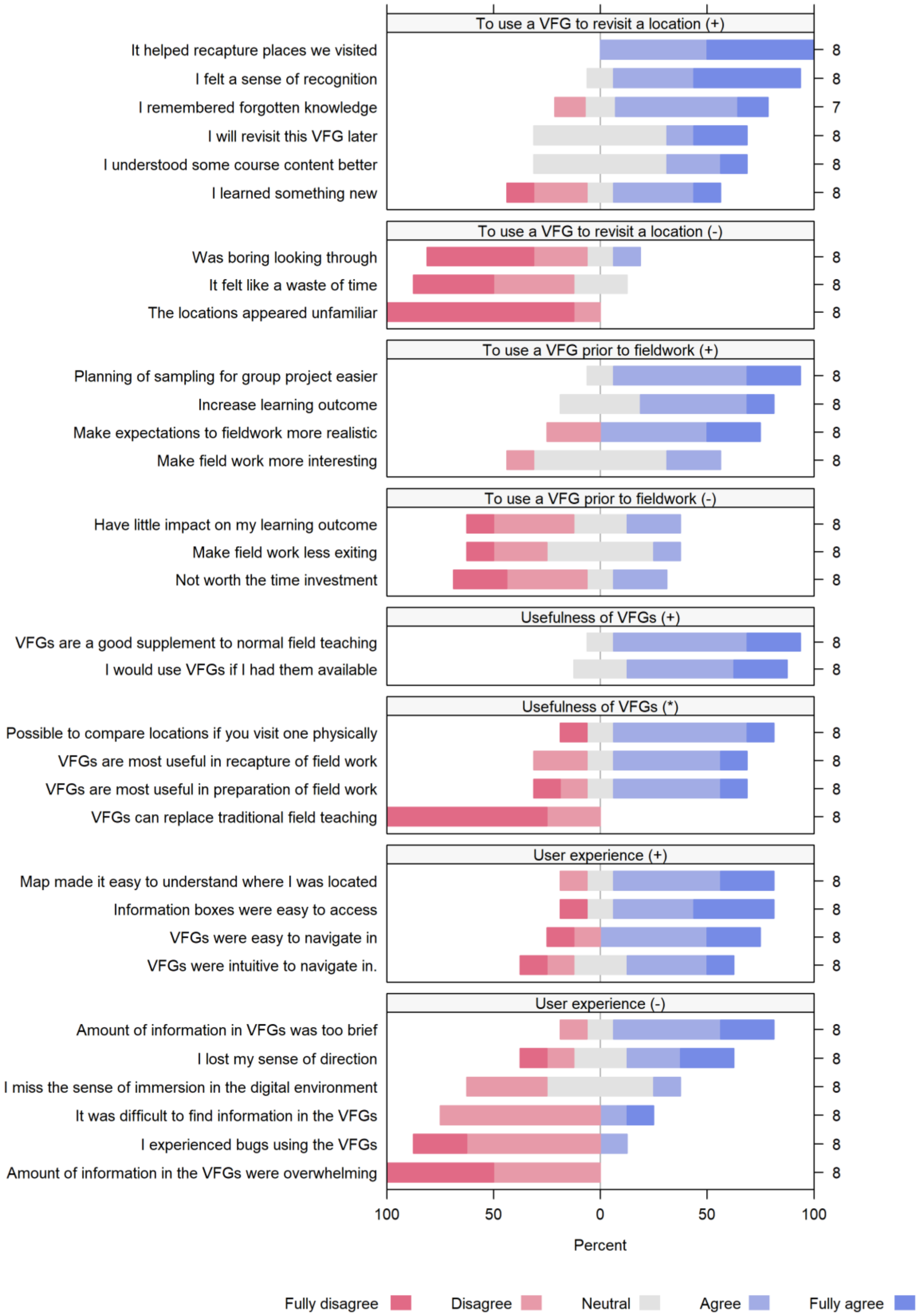

***Figure 2**. Summary of student feedback (n = 8) after exploring at least two VFGs. The statements (condensed in figure, full version in Appendix 6.7) were ranked after a five-level Likert-scale from 1 - Fully disagree, to 5 – Fully agree. In the figure, statements are binned into panels based on category and whether the statements were positive (+), negative (-) or neutral (*). The statements are ordered from highest to lowest score within each panel.*

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3.3 Observations and Feedback from learning activity using VFGs

The students used the VFGs actively during the learning activity. They roamed the location on their computers and shared their personal impressions of the landscapes with the group. Interestingly, the students noticed different things. The activity clearly triggered discussions related to field-acquired knowledge and practiced the reading of landscapes. Oral feedback from the students was that the activity was engaging, useful and fun.

4 Reflections and Discussion

We aimed at developing and testing a digital tool for improving preparation, post-field recapitulation activities and assessment of fieldwork in arctic terrestrial biology at UNIS. Further, we wanted this digital tool to be relatively simple to produce and use, and not require specialized digital competence or advanced equipment. Based on the limited feedback and experience collected so far, the virtual field guides (VFGs) we have developed seem to fulfil our aims.

4.1 Making VFGs

Our field guides require limited investments in equipment and software. The production does not require specialised competence beyond common computer skills (although knowledge of photo handling is an advantage), but it does require some time investment. If time is limited, and resources to employ technical support is limited, an alternative can be to embed the VFG production as a learning activity in a course. In this way, students will themselves extend their field learning and be forced to relate field activities to theory. At the same time, it would be possible to build up a resource bank of VFGs, which again can be re-used in other courses. This type of student-led production of teaching material has been utilized in, e.g., production of video tutorials (https://teach2learn.w.uib.no/project-description/ and https://sarahnolan15.wixsite.com/fieldworkforstudents). A possible pitfall when implementing activities such as making instruction videos is that students may allocate too much time to video-editing compared to discipline content (France et al., 2015).

Most students that tested the VFGs found them relatively easy to navigate, but they found the amount of information too brief (Figure 2). To add more information would make the VFGs more demanding to produce, and this must be evaluated towards the planned use of the VFGs. The students evaluating the VFGs did this in retrospect, thus the feedback on this point may therefore be a bit biased. These students had already been in the field, visited the locations the VFGs represented, and passed their exams. They were already well informed, which may influence their opinion on the level of information content. For a new student, on the other hand, the information level in the VFGs may be overwhelming.

We believe that it is better to keep the core content of the VFGs rather brief, and include links to other sources. In this way, we hope the VFGs appear feasible to look through for students without any prior knowledge of arctic terrestrial biology, and at the same time provide students with good sources of information. It is always possible to extend VFGs with additional content later, so our suggestion is to start brief, and extend after demand.

Although it is not very complicated to make VFGs, it is always a bit of work to learn a new software and new equipment. To lower the threshold for educators to start making their own VFGs, we have arranged practical workshops at the three institutions involved in the FieldPass project (The University Centre in Svalbard, The University of Bergen and the University of Oslo), focusing on how you get your 360-degree photographs into a VFG. We have also provided more detailed descriptions of the process in the Appendix of this publication.

4.2 Use of VFGs for preparation of fieldwork

Based on student feedback evaluating the use of VFGs as a tool for preparation in retrospect, most agreed or strongly agreed that the VFGs can be expected to improve the planning phase of fieldwork, and thus create better alignment between expectations and reality. We are aware that our collected feedback is based on a limited number of students, but our findings are in line with other case-studies using VFGs as preparation (France et al., 2015), and former findings from, e.g., preparation of fieldwork in geography using VFGs (Cliffe, 2017). We are therefore confident that our VFGs will aid preparation of learning activities in the field, particularly in Svalbard. Very few students have former experience from High-Arctic regions. Thus, the mismatch between expectations and reality is often very high for students coming to Svalbard. VFGs provide scaffolding for a student's interpretation of field instructions and information prior to field work, reducing this mismatch.

4.3 Use of VFGs for recapitulation and practice of fieldwork skills

Based on the survey responses, the VFGs provided students with a sense of recognition, helped repetition, and have the potential to increase the overall learning outcome from fieldwork. The respondents of the survey had been visiting the exact same locations they revisited using VFGs. This may trigger memories and feelings that enhance or influence learning (e.g., Buchanan, 2007; LaBar & Cabeza, 2006).

However, in order to practice more general field skills, there was no need to have visited the exact same location(s) as the VFGs represents. By using VFGs in a classroom exercise, providing a specific case to be solved using a set of VFGs, we learned that the VFGs could be used to practice field skills achieved in other high-arctic locations. It is important that VFGs are reusable to be worth the investment and effort (France et al., 2015). We argue that using VFGs in this manner will be useful for students without experience from High-Arctic fieldwork as well, for instance in exercises transferring knowledge achieved during alpine field settings into an arctic environment. In workshops with employees, we have made various skill-focused case studies utilizing these VFGs. These case studies have been largely decoupled from knowledge of arctic terrestrial biology. The focus has for instance been evaluating different statistical sampling designs in various environments, or placement of sampling equipment in relation to physical factors such as slope, sun angle, distance from water bodies etc. The VFGs can also be useful as part of the digital toolbox used by geologists (e.g., https://www.svalbox.no/). Thus, the available VFGs can easily be used in a range of classroom activities, also beyond UNIS.

4.4 VFGs are a compliment to field teaching to be develop further

Students regarded VFGs as good tool to combine with field teaching in order to enforce previous knowledge and better prepare students for fieldwork, but VFGs cannot replace fieldwork (Figure 2). To replace fieldwork was however never the intention. Rather, we aimed at finding a digital tool for improving preparation, recapitulation activities and assessment of fieldwork to achieve better constructive alignment of field activities. We have shown that VFGs can improve preparation and post-field repetition and transferability of acquired knowledge and skills, but we have not yet been able to test the VFGs in an assessment setting. However, we believe that VFGs can be utilized to evaluate certain field skills. A case similar to the classroom exercise presented here could easily be adapted to a case suitable for, e.g., an oral exam with preparation time. We hope to be able to test this in the near future.

Through our student panels and open comments in the survey, a suggested improvement of the VFGs was to add seasonal variation. At present, we have developed three VFGs with seasonal information embedded (pictures taken every month throughout a year). We have added some drone images to provide an additional bird's-eye view to these locations. We believe that adding these elements will make the VFGs even more effective in bridging the gap between theory and practice.

Our initial aim was to provide students with a more realistic view of different habitats in Svalbard. It was envisioned that students would explore VFGs through tasks designed by the teacher. These tasks were not planned upfront, as they would depend on the intended learning outcomes of the different courses that potentially would utilize the VFGs. Thus, the VFGs were not designed with specific learning outcomes in mind. After testing various learning activities combined with VFGs, it has become evident that producing "all-purpose" VFGs has some drawbacks. If VFGs had been specifically planned and designed around exploring a particular biological concept, this would have ensured that the right type of pictures was taken and included. Moreover, the development of tailored learning activities alongside the VFGs could have fully utilized their potential.

5 Concluding remarks

In conclusion, VFGs have the potential to improve the constructive alignment of field activities, and thus increase the overall learning outcome. The relatively low start-up cost and the potential for expansion when integrated into courses are great aspects of the VFGs. Although VFGs cannot fully replace the experience of actual fieldwork, VFGs provide valuable opportunities for students to repeat and recapture past fieldwork experiences and gain insight into different habitats and field situations they have not experienced themselves. VFGs provide a "closer to reality" learning experience compared to simplified textbook illustrations. However, they do require the assistance of technical personnel for ongoing maintenance and updates. In retrospect, our VFGs might have benefited from being more targeted towards specific learning outcomes and planned tasks where the VFGs were to be used. When developing new VFGs, we suggest clearly identifying which problems are to be addressed, and consider whether they can be effectively solved using a VFG before designing the content.

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6 Appendices

Appendices 6.1-6.5 give an overview of the steps we went through to create the Virtual Field Guides. There are other and probably better ways to build similar VFGs, but this is how it unfolded in our case. The software and equipment we used to create these types of guides are not exclusive and represent an example. Other similar alternatives should work equally well. Technical questions can be directed to simen.hjelle@outlook.com.

6.1 Capturing 360-degree photographs

To capture 360-degree photographs we used a 360-degree camera (Insta360 ONE X) mounted on a tripod. This camera was easy to use, and not more complicated than the one found on a phone. We experienced some issues when the camera was set to communicate with a smartphone and therefore opted to use it manually, set to capture in RAW format on a three-second timer. Another issue with the camera was the battery's poor cold tolerance, which drained the battery rapidly and required a power bank to almost constantly be plugged into the camera.

When shooting, we did a minimum of two 360-degree photographs without moving the camera between the shots. For each image, the cameraperson moved to a different spot, to not cover the same area they did in the previous image (Figure 3). Then, the image information covered by the cameraperson in the first shot can be taken from the second shot and merged into a new image. The same principle can be applied to anything that is movable between shots. If something is not movable, it can be removed during post-processing (Appendix 6.4).

We took GPS coordinates for each photo location. For each location, we aimed to take photos from about 20 different spots. The number of spots depended on time we had and how many imaged we thought were needed to capture a location We additionally used a digital single-lens reflex camera (Pentax K100, 50mm) to take overview pictures, close ups of plants, or other elements of interest. These were later utilized inside the guide and on the website. For each location, we also made lists over common species and habitat descriptions. The ideal conditions for taking 360-degree photographs were overcast/cloudy conditions, because strong shadows caused by direct sunlight were difficult to remove in post-processing.

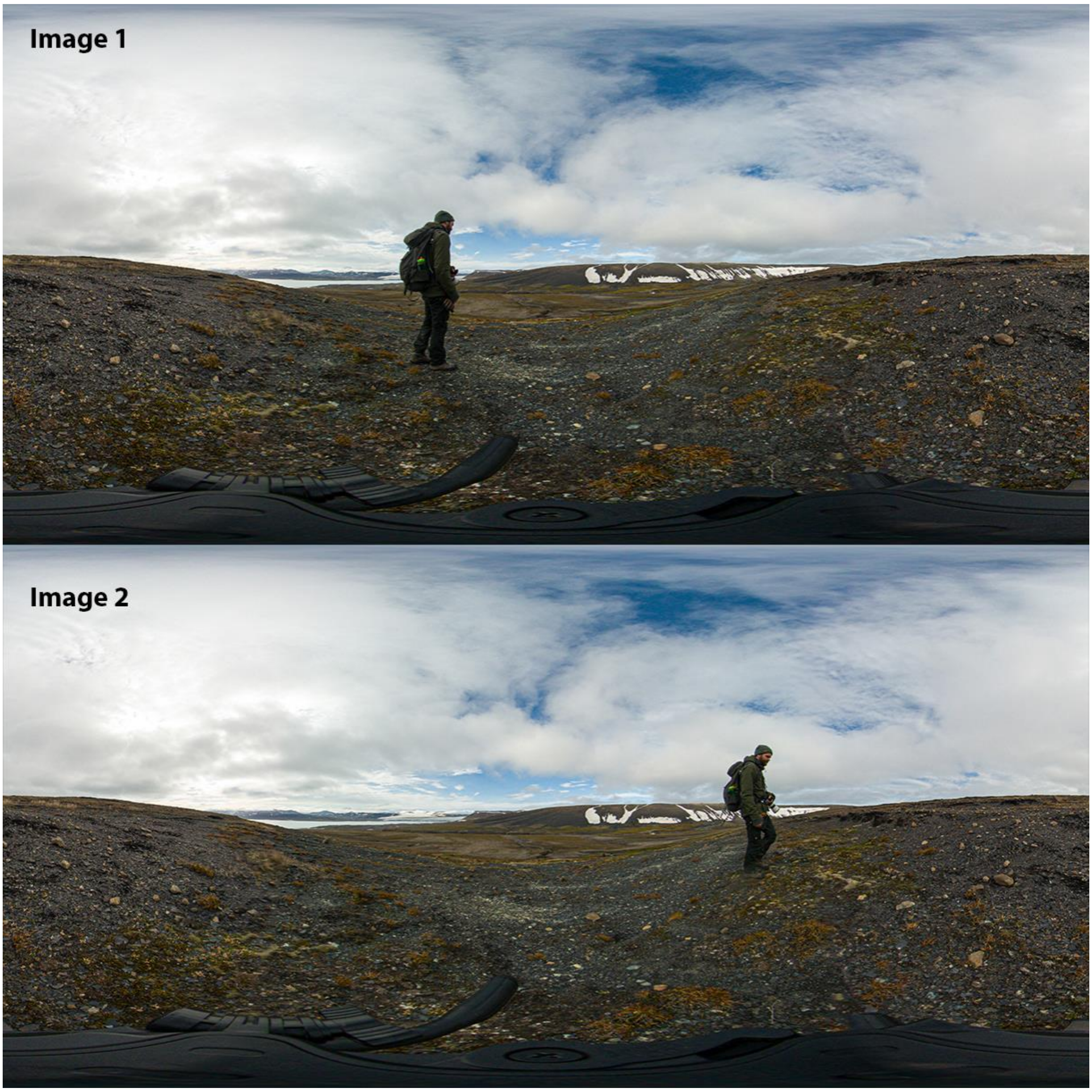

Figure 3. *Example of how we shot 360-degree photographs. After the first photograph (Image 1), the cameraperson moves to a new location for the second photograph (Image 2). This allows using background information from Image 1 to remove the subject.*

6.2 Post-Processing - Software

We utilized the following software to process the images after capture in the field and build the VFGs:

- Insta360 Studio – We used this software to open our images, look through them, sort them and export them into .png files.
- Adobe Ligthroom – Used to colour-correct images.
- Adobe Photoshop – Used mainly for its many tools that allow for cloning of pixels, and removal of image clutter (such as the tripod) in post.
- Pano2VR – Used to build 360-degree tours.

6.3 Post-Processing - Sorting and Exporting

The 360-degree photographs coming directly from the camera were not easy to work with or even registered as 360-degree photographs when opened in software such as Pano2VR. Therefore, we had to utilize Insta360 studio to open and view images, sort out images we wished for the final product and export them. After possessing with Insta360 studio, Pano2VR could properly project them as 360-degree photographs.

6.4 Post-Processing - Editing your Shots

Before editing images in Adobe Photoshop, we did basic colour correction in Adobe Lightroom. Mainly altering brightness and contrast and increasing sharpness. The goal was to increase visibility, while not distorting the natural look of the image/location. We saved the correction preformed as a presets and applied the same correction to all images. However, different location could require different presets.

Next, images were opened in Adobe Photoshop. As explained in Appendix 6.1, we had two pictures per spot. We opened the image pair and put both into the same document, but in different layers. Then any objects that moved during the two images could be simply erased (Figure 4) using the Eraser Tool and objects that did not move, but required removal, were removed using the Spot Healing Brush Tool (Figure 4).

Figure 4. *Removal of distracting elements. Circle (cameraperson) was removed by overlapping the two images (keep on separate layers) and erasing with the Eraser Tool (Adobe Photoshop). Elements in squares were removed using the Spot Healing Brush Tool (Adobe Photoshop). Notice some artefacts from removal of tripod, but smaller elements such as the people are unnoticeable.*

6.5 Building and sharing VFGs

Once the processing of the 360-degree photographs was completed, we used the software Pano2VR to construct the guides. The process of using Pano2VR to create 360-degree tours are explained in the documentation of the software (https://ggnome.com/doc/pano2vr/). In Pano2VR you can import your photos, add metadata for each photo (Title, description, coordinates etc.). Then link the photos together, and quite quickly set up a basic tour. The main part that took time were building all of the user interface, all of its functionality, adding all of the information and testing and fixing issues. So, must of the time were spent in the tool “Skin Editor” that comes with Pano2VR, where most of this is achieved. A technical hurdle we faced were making sure the guides worked on different devices and different screen resolution. Especially on iOS devices, the guides worked poorly (support for full-screen mode for example missing). And things could look bad on certain screen resolutions, and with different screen scaling. Here, we just had to do a lot of testing and tweaking, and adding dynamic functionality that scaled elements depending on what device was used, and what screen resolution. Once we had finished a guide, it can be exported out as basic web code (HTML, CSS, Javascript) and your image files and other assets. To share it online, we just upload all the files to a web server (In its own folder), and linked to the index.html file (Or just the folder containing the index.file). Each guide ending up being around 80 to 100 megabytes in size.

6.6 Time budget

Time used varied between the different stages. Learning how to operate the camera and editing the photos later can be done within a day of practice, but one could extend this to one work week and include more testing and planning. The fieldwork took usually one day per location, but if the travel distance is short between locations, more of them can be covered in the same day. We spent far more time in post-production. Learning the software Pano2VR, creating a visual profile and experimenting with ideas. And that part can be achieved in around 2 to 4 work weeks. For building the guides, there is a theoretical part and technical part. If the theoretical part is done, such as writing the text to be included, the technical part of building the guides can take 1 to 2 work weeks. As many elements made for one guide could be re-used in newer guides, and work efficiency increasing over time, a larger VFG could be built in one work week. But it’s still good to leave some extra time for bug fixes and technical issues. Time budget for a smaller 360-degree tour, would be around 2-3 days. Time spent can still vary a lot, if goals are not clear and one needs to experiment a lot, things can take longer. A technical bug can also eat up a lot of time. And once one has tested the guides and received feedback, it would be smart to allocate 1-3 days to per guide to polish/change them based on that feedback. Overall, as seen in Table 2, it can take up to 10 months to complete 10 larger guides. If more time is left, it’s always possible to create more guides or put even more effort into the individual guides. Or aim for fewer guides, such as 5 and completion time can then be half a year. These times are also a rough and generous estimate. Since the work on our guides was done in smaller segments over 1 - 2 years, it’s hard to give a precise time estimate.

Table 2. *A rough and generous estimate of time needed to create VFGs. Time may deviate a lot from this, but it's here to give an idea of how much time is needed for such a project. Time budget is mainly of the technical work.*

Task/stage	Estimated time
Planning / testing equipment	0.25 months
Fieldwork / shooting	0.25 – 0.5 months
Learning software, creating visual profile etc.	0.5 – 1 months
Building 10 large guides	5 – 6 months
Testing and polishing	1 – 2 months
Total	7 – 10 months

6.7 Survey among former students

The full statements with headings (in bold) as they were phrased in the survey.
After testing out the VFGs and revisit places you were two years ago, how would you rate the following statements?
The VFGs made me understand some of the course content better
Looking through the VFGs felt like a waste of time
The VFGs helped me recapture the places we visited
It was boring looking through the VFGs
Most locations appeared unfamiliar to me.
The VFGs made me remember knowledge I had forgotten
The VFGs made me feel a sense of recognition
The VFGs made me learn something new.
I will revisit this VFG at a later date
Imagine you had access to VFGs prior to the fieldwork in xxx, and rate the following statements
I think exploring VFGs prior to my arrival in Svalbard would have made my expectations to fieldwork more realistic.
I think exploring VFGs prior to field work would make the field work more interesting
I think exploring VFGs prior to field work would make the field work less exiting
I think exploring VFGs prior to field work would increase my learning outcome
I think exploring VFGs prior to field work would not be worth the time investment
I think exploring VFGs prior to field work would have little impact on my learning outcome
I think exploring VFGs prior to field work would have made the planning of sampling for the group project easier
In general, how would you rate these statements about the use of VFGs in a teaching environment?
I would use VFGs if I had them available during my course
VFGs can replace traditional field teaching
VFGs can be used to compare similar environments/habitats across many locations if you visit at least one of them physically.
VFGs are most useful in preparation of field work
VFGs are most useful in recapture of field work
VFGs are a good tool to in combination with normal field teaching
Other comments regarding usefulness of VFGs
Regarding the technical aspect of the VFGs, how would you rate the following statements?
The VFGs were easy to navigate in
The information boxes were easy to access
The map made it easy to understand where I was located
The amount of information in the VFGs was too brief

I lost my sense of direction when moving between pictures
The VFGs were intuitive to navigate in.
I miss the true sense of immersion in the digital environment
The amount of information in the VFGs were overwhelming
It was difficult to find information in the VFGs
I experienced bugs using the VFGs (Please clarify in the suggestion box bellow)
Other comments/Suggestions for improvements regarding ease of use