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

Pernille Eidesen¹ and S S Hjelle²

¹Affiliation not available
²Department of Biosciences, Department of Arctic Biology, University of Oslo, The University Centre in Svalbard

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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 recap 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° pictures 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 not used VFGs as an integrated tool to prepare their field course. Data were collected through an anonymous survey. Eight of 16 students responded. We also collected experience from arranging a post-fieldwork learning activity (16 students) that required knowledge of “reading landscapes”, which are categorized as a typical field skill. The current feedback indicate that VFGs provide students with a more realistic picture of what awaits them in the field, and aid preparing, planning, and recap of fieldwork, but cannot substitute fieldwork. We further exemplify that 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.

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P.B. Eidesen, and S.S. Hjelle
Department of Biosciences, University of Oslo
Department of Arctic Biology, The University Centre in Svalbard

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 recap 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° pictures 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 not used VFGs as an integrated tool to prepare their field course. Data were collected through an anonymous survey. Eight of 16 students responded. We also collected experience from arranging a post-fieldwork learning activity (16 students) that required knowledge of “reading landscapes”, which are categorized as a typical field skill. The current feedback indicate that VFGs provide students with a more realistic picture of what awaits them in the field, and aid preparing, planning, and recap of fieldwork, but cannot substitute fieldwork. We further exemplify that 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 enable 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 the principle of constructive alignment (Biggs & Tang, 2011). 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

However, when it comes to field activities, we tend to neglect the importance of preparation, recap and assessment (Eidesen et al., 2017; Lonergan & Andresen, 1988). This was for instance shown in an internal case-study at The University Centre in Svalbard (UNIS), focusing on potential for improvement of field activities (Eidesen et al., 2017). They revealed that fieldwork, in spite being highly appreciated by students (The University Centre in Svalbard, 2010, 2020), often lacked proper preparation, and proper sum-up/evaluation (Eidesen et al., 2017). Time constraints were often the reason for down prioritizing briefing/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 assume 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 recap activities were clearly required (Eidesen et al., 2017). In addition, there was a need to develop and test alternative ways of assessment targeted towards intended learning outcomes related to skills and competences. To search for solutions in the fast-growing digital toolbox was a natural place to start.

1.3 Utilize Virtual Field Guides as digital bridges to improve fieldwork

To combine real-world experiences with various levels of virtual reality (VR) or augmented reality (AR) in educational settings are already 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 instance improved preparation of fieldwork (Cliffe, 2017). What type of virtual elements to use depend 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, recap and assessment of fieldwork related to arctic biology at UNIS. It was important that it should not require too much expertise to develop, and be possible to use by the students before arriving. Thus, there should not be a need for additional equipment besides a computer and on-line access. We therefor 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 create 360°-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 with fieldwork as an important component of the course. 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 less field activities in 2021. Thus, after development, we have had reduced possibility to test the VFGs in preparation for fieldwork.

1.4 Objectives

In this paper, we present 1) how we made VFGs (360°-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 recap-activity using VFGs, 4) discuss our current results, and reflect on how to expand the use of VFGs to prepare, recap and assess field-related learning outcomes.

2 METHODS

Note to reader: If you read this method section with the aim of making your own VFGs, we suggest looking into our VFGs at www.360.learningacticbiology.info before diving into the detailed description provided in Appendix.

2.1 Making Virtual Field Guides - VFGs

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

360° pictures were taken at regular intervals moving across the landscape using Insta360 ONE camera, 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 web-page in Wordpress (www.360.learningacticbiology.info). Detailed description of how to make a VFG is provided in Appendix. During the development phase, the VFGs were tested on a paid panel of four students that provided feedback on a demo-version.
The initial investment in equipment was about 10 000 NOK (Appendix Table 2). Time investment in learning the camera, software and photo handling was done during a day practicing and doing a test shoot. The full VFGs with additional information embedded require a time investment of around two workweeks (minimum), whereas the simpler, pure observational 360°-tours required about 2 to 3 workdays (see Appendix 5.6 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 (www.nettskjema.no). The survey consisted 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 5.7). The questions aimed at probing four aspects: 1) their experience with using VFGs to revisit field locations they had visited physically in 2019, 2) their opinion (in retro-respect) regarding usefulness of VFGs for preparation of fieldwork, 3) their general impression of usefulness of VFGs, and 4) user experience. The survey was open for two weeks.

Data from the survey was 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 they 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 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.
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/](https://artsdatabanken.no/) October 2021. Red List rating: NT- Near Threatened; VU – Vulnerable; EN -Endangered; CE-Critically Endangered

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

They worked with the task for about an hour, and at the end, they simultaneously shared their decision. Then we discussed the rationale behind each group’s decision.

One of the authors were 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 were provided orally immediately after the learning activity.

3 RESULTS

3.1 Available VFGs per February 2022

We have currently developed and published eight VFGs. In addition, we have published six miniVFGs or 360-Tours that are simpler overviews (fewer pictures and less additional information) of locations at [www.360.learningarcticbiology.info](http://www.360.learningarcticbiology.info) (Fig. 1).
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 to learn something new when revisiting locations through VFGs (Fig. 2). When asked about potentials (in retro-respect) 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 to field work more realistic. Some also expected increased learning outcome. They regarded VFGs as good tool to combine with field teaching, although VFGs should not be used as a replacement (Fig. 2). Through open comments, it was suggested to 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 in, which also was elaborated in the open feed-back comments. Elements you had to search for (not listed in the explorer) was not appreciated.
Figure 2. Summary of student feedback (n = 8) after exploring at least two VFGs. The statements to the left are abbreviations of the actual statements (Appendix 5.6), ranked after a five level Likert-scale from 1 - Fully disagree, to 5 – Fully agree. The statements are sorted in four categories 1) experience with using VFGs to revisit field locations they had visited physically, 2) their opinion (in retro-respect) regarding usefulness of VFGs for preparation of fieldwork, 3) their general impression of usefulness of VFGs, and 4) user experience. The panels are binned after category, and within each category on whether the statements were positive (+), negative (-) or neutral (*). The statements are ordered from highest to lowest score within each panel.
3.3 Observations and Feedback from learning activity using VFGs

The students used the VFGs actively during the learning activity. The roamed the location on their computers, and shared their personal impressions of the landscapes in to 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, recap 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 feed-back 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 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 lead 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 in video-editing compared to discipline content (e.g. see Chapter 7; (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 (Fig 2). To add more information make the VFGs more demanding to produce, and must be evaluated towards the planned use of the VFGs. The students evaluating the VFGs did this in retro respect. 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 have 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 rather link out 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 guide students that want extra information to good sources of information. It is always possible to extend VFGs with additional content later on, 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 currently plan to arrange 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 pictures into a VFG. Based on the experiences from these workshops, we may assemble an on-line tutorial to make it easier for both educators and students to make their own VFGs. Such a tutorial would probably make it easier for educators to use students to make VFGs as a learning activity. Whether we will manage to make such a tutorial is however depending on available capacity and funding. However, for institutions

4.2 Use of VFGs for preparation of fieldwork

Based on student-feedback evaluating the use of VFGs as a tool for preparation in retro-respect, most agreed or strongly agreed to 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 student’s interpretation of field instructions and information prior to field work, reducing this mismatch.

4.3 Use of VFGs for recap and practice of fieldwork skills

Based on the survey response, the VFGs provided 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 (Chapter 7)(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 have 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 geologist (see e.g. https://www.svalbox.no/). Thus, the available VFGs can easily be used in a range of classroom activities, also outside 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 (Fig. 2). To replace fieldwork was however never the intention – we aimed at finding a digital tool for improving preparation, recap and assessment of fieldwork to achieve better constructive alignment of field activities. We have shown that VFGs can improve preparation and recap of fieldwork, but not yet been able to test the VFGs as part of 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 been adapted to a case suitable for e.g. an oral exam with preparation time. We hope to be able to test this in near future.

Through our student panels and open comments in the survey, a suggested improvement of the VFGs was to add seasonal variation. We are currently in the process of making two new VFGs with seasonal information embedded, and are currently collecting 360° pictures from the same spots over time. We are also collecting drone-images to provide an additional bird-eye view to these locations. We hope that adding these elements will make the VFGs even more efficient in bridging the gap between theory and practice.
5 APPENDIX

Appendix 5.1-5.5 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. We have listed what software and equipment one should invest in to create these types of guides (Table 2). Technical questions can be directed to simen.hjelle@outlook.com.

Table 2. A list of software and equipment used to build virtual field guides, including approximate costs at the time (2019) and how it was utilized. *The camera was acquired in 2019. There are now newer versions as well as cameras by competing brands. The base version of Insta360 ONE X did not do well in the cold, and buying a cold tolerant battery is recommended if it is being used in a cold climate. Not included are costs related to hosting the VFGs online.

<table>
<thead>
<tr>
<th>Equipment / Software</th>
<th>Cost</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adobe Photoshop + Lightroom</td>
<td>Subscription based, around 200 NOK per month.</td>
<td>Used to edit photos to achieve a more professional result. Lightroom is alternative, but comes with a basic Photoshop subscription.</td>
</tr>
<tr>
<td>Insta360 Studio</td>
<td>Free</td>
<td>Viewing and exporting photos.</td>
</tr>
<tr>
<td>Tripod</td>
<td>Around 1,000 NOK</td>
<td>Stable capture of photos.</td>
</tr>
<tr>
<td>Power Bank</td>
<td>Around 500 NOK</td>
<td>Extra battery power in case camera runs out.</td>
</tr>
<tr>
<td>Hiking GPS</td>
<td>Prices usually starts at about 1,000 NOK</td>
<td>Get the GPS location of photos.</td>
</tr>
<tr>
<td>Insta360 ONE X*</td>
<td>Around 3,500 NOK</td>
<td>360-Degree Camera.</td>
</tr>
<tr>
<td>Compatible Smartphone</td>
<td>N/A</td>
<td>Optional. But can be linked to 360-camera and used to capture additional still images.</td>
</tr>
<tr>
<td>Pano2VR Pro</td>
<td>349 EUR. One-time payment.</td>
<td>Software used to build VFGs.</td>
</tr>
</tbody>
</table>

5.1 Capturing 360-degree Photographs

To capture 360-degree images we used a Insta360 ONE X camera 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. We therefore opted to use it manually, capturing in RAW format on a 3 second timer. Another issue with the camera was the batteries poor cold resistance, this 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 images on each spot taking care not moving the camera between the two shots. This enabled removal of the camera person or any other objects clutter the final image. We moved object that could be moved between the two shots, so they were not covering the same area as in the first shot, then they could be removed with ease later (Fig. 3). Objects not possible to move physically between the shots, could be removed by other means (Appendix 5.4).

We took GPS coordinates for each image. For each location, we aimed to do the picture-procedure at 20 different spots. The number of spots depended on time and need for coverage at the location. We 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-images were overcast/cloudy conditions. As strong shadows caused by direct sunlight were difficult to remove.

Figure 3. Example of how to shoot 360-images. Subject/ Cameraman moves to a new location in the second image. This allows using background information from Image 1 to remove the subject.

5.2 Post-Processing - Software

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

- Insta360 Studio – We used this software to open our images and export them into .png files. As they come in Insta360’s own file format. There is likely similar software for other brands of 360-degree cameras.
- Adobe Lightroom – Used to colour correct images.
- Adobe Photoshop – Well known image editor. Similar software might meet most needs but can lack certain specialized tools. Similar freeware such as Gimp and Pain.NET can be used.
- Pano2VR – Used to build 360-tours. Supports both 360-degree images and video. From experience, it’s the tool that offers the most flexibility, while also being fairly simple to use.

5.3 Post-Processing - Sorting and Exporting

The 360-degree images coming directly from the camera were not easy to work with or even registered as 360-degree images 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 images.

5.4 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 5.1, 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 (Fig. 4) using the Eraser Tool and objects that did not move, but required removal were removed using the Spot Healing Brush Tool (Fig 4).

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

5.5 Building and sharing VFGs

Once the processing of the 360-degree images 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 (ref). Graphical user interface elements such as buttons, info boxes and mini map was designed in Adobe Photoshop. The largest technical difficulty we faced were making sure the guides worked on different devices and different screen resolution. We currently lack a good solution here. Especially on iOS devices, the guides worked poorly (support for full-screen mode often missing). A lot of tweaking and testing was required on this step. The finished guides were uploaded to our Wordpress webpage, via the dedicated Pano2VR plugin called “Garden Gnome Package”. Each guide ending up being around 80 to 100 megabytes in size. We did not experience any performance issues running the guides.

5.6 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-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 Tabel 3, 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 3. A rough and generous estimate of time needed to create VFG’s. 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.

<table>
<thead>
<tr>
<th>Task/stage</th>
<th>Estimated time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning / testing equipment</td>
<td>0.25 months</td>
</tr>
<tr>
<td>Fieldwork / shooting</td>
<td>0.25 – 0.5 months</td>
</tr>
<tr>
<td>Learning software, creating visual profile etc.</td>
<td>0.5 – 1 months</td>
</tr>
<tr>
<td>Building 10 large guides</td>
<td>5 – 6 months</td>
</tr>
<tr>
<td>Testing and polishing</td>
<td>1 – 2 months</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7 – 10 months</strong></td>
</tr>
</tbody>
</table>

5.7 Survey among former students

The full statements with heading (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?**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>I would use VFGs if I had them available during my course</td>
<td></td>
</tr>
<tr>
<td>VFGs can replace traditional field teaching</td>
<td></td>
</tr>
<tr>
<td>VFGs can be used to compare similar environments/habitats across many locations if you visit at least one of them physically.</td>
<td></td>
</tr>
<tr>
<td>VFGs are most useful in preparation of field work</td>
<td></td>
</tr>
<tr>
<td>VFGs are most useful in recapture of field work</td>
<td></td>
</tr>
<tr>
<td>VFGs are a good tool to in combination with normal field teaching</td>
<td></td>
</tr>
<tr>
<td>Other comments regarding usefulness of VFGs</td>
<td></td>
</tr>
</tbody>
</table>

**Regarding the technical aspect of the VFGs, how would you rate the following statements?**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>The VFGs were easy to navigate in</td>
<td></td>
</tr>
<tr>
<td>The information boxes were easy to access</td>
<td></td>
</tr>
<tr>
<td>The map made it easy to understand where I was located</td>
<td></td>
</tr>
<tr>
<td>The amount of information in the VFGs was too brief</td>
<td></td>
</tr>
<tr>
<td>I lost my sense of direction when moving between pictures</td>
<td></td>
</tr>
<tr>
<td>The VFGs were intuitive to navigate in</td>
<td></td>
</tr>
<tr>
<td>I miss the true sense of immersion in the digital environment</td>
<td></td>
</tr>
<tr>
<td>The amount of information in the VFGs were overwhelming</td>
<td></td>
</tr>
<tr>
<td>It was difficult to find information in the VFGs</td>
<td></td>
</tr>
<tr>
<td>I experienced bugs using the VFGs (Please clarify in the suggestion box bellow)</td>
<td></td>
</tr>
<tr>
<td>Other comments/Suggestions for improvements regarding ease of use</td>
<td></td>
</tr>
</tbody>
</table>

### 6 ACKNOWLEDGMENTS

We would like to thank students enrolled in Arctic Biology courses at UNIS for providing valuable feedback and photos used in the guides. Anne Bruls and Xenia Uffrecht for doing additional 360-photography, and Tina Dahl for administrative support. We thank Norwegian Directorate for Higher Education and Skills (HKdir), Centre for Excellence in Biology Education (bioCEED), Svalbard environmental fund and the University Centre in Svalbard (UNIS) for funding the project.

### REFERENCES

Adams, C. J. (2020). A Constructively Aligned First-Year Laboratory Course. *Journal of Chemical Education, 97*(7), 1863-1873. [https://doi.org/10.1021/acs.jchemed.0c00166](https://doi.org/10.1021/acs.jchemed.0c00166)


