Southern Regional Hub-funded project

Project Report

Bring Your Own Device (BYOD) and We Bring a Device (WeBAD) to field class: integrating digital and community mapping in field-based coursework

Teaching framework for tertiary educators

AKO AOTEAROA

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

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AOTEAROA
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Executive Summary

This report provides an analysis and evaluation of a Bring Your Own Device (BYOD) initiative for field trips in Earth Science classes. The goals of the Ako Aotearoa-funded project are to integrate relevant leading-edge tools into the students' curriculum for improved field trip experiences while simultaneously ensuring students are equipped with the latest industry-standard technical skills employers seek. This project report details (i) a new teaching framework for tertiary educators seeking to implement BYOD or smart devices in field trips, (ii) the results of student and staff surveys aimed towards monitoring challenges and successes of using BYOD, and (iii) our specific recommendations and a workflow for using the teaching framework in any field science. Over the course of the work, we identified technological barriers to entry and introduced a new initiative We Bring a Device (WeBAD). Overall, we find that there are numerous strengths of using BYOD (or devices in general) in field courses, and so long as minor challenges are addressed, there are several pathways to achieving the goals above.

Overview

Smart device apps are revolutionising how information is recorded outside of the office in all types of workplaces. Despite the growing utility and availability of apps built for field work, few tertiary classes actively use them to teach field skills and prepare work-ready graduates. The objective of this research project is to investigate the successes and challenges of using smart devices in geology and geography field classes. In this document, we provide a pedagogy-focused teaching framework for using smart devices within and/or implementing a Bring Your Own Device (BYOD) and We Bring a Device (WeBAD) programme into tertiary field trips. The framework and our recommendations are informed by 2 years of use and student and staff survey data in Geology and Geography classes at the University of Canterbury– survey data is provided in an appendix at the end of the report. A video series, aimed at making the teaching framework more accessible and explaining what the app is actually capable of doing, will be available on YouTube via Ako Aotearoa's project website (or www.stahlgeology.com). Additional project information can be found at [Ako Aotearoa's project site](https://ako.ac.nz/).

Figure 1: BYOD/WeBAD Teaching Framework

The BYOD/WeBAD Teaching Framework

Origin

Our framework (Fig. 1) is modelled after the Ministry of Education's Māori Tertiary Education Framework and follows the *niho taniwha* (tooth of the taniwha) structure to emphasise the interdependence of teeth in the hierarchy. Each tooth contains links (roman numerals) to relevant sections in the remainder of this document. The purpose of this framework is to inform tertiary educators about best practices for using devices and implementing BYOD in field sciences. Our goal is not to provide detailed tutorials of the apps, software, or technology; these are provided by available online resources (see our *Critical Elements* section).

Methods

We produced the BYOD teaching framework in January 2019 based on one year of teaching experience across a few field trips in different geology and geography courses, the teaching team's research experience using GPS systems in field work, and one year of survey data (description below). The results are discussed in an Ako Aotearoa interim report available at Ako Aotearoa's project site. Subsequent assessment, informal discussion with staff and students, and surveys have shown that the 'teeth' are important components to a successful BYOD pedagogy.

In this report, we base our updated recommendations and improved framework descriptions on three lines of evidence (i) Likert-scale ordinal student survey data, (ii) written feedback from student questionnaires, and (iii) written feedback from staff. Five courses and approximately 100 students were surveyed. All student surveys were anonymous, and we attempt only to track progress of the "classroom" as a unit of analysis, rather than individual students. While detailed quantitative and qualitative analyses (e.g., controlling for app usage in past coursework, comparing outcomes by multi-day or single-day field trips) are outside the scope of this project, our preliminary findings and updates from 2019 are presented below and in the appendices. We also note that while we attempt to map our survey data to the framework, and in particular intended learner outcomes, the data do not readily allow us to do so. Instead, we effectively measure student perceptions of the intended learning outcomes. Staff feedback was sought via a written questionnaire and informal workshops held with the BYOD teaching team.

Overall Aspiration – improved learner outcomes in field sciences using BYOD

The workplace is no longer confined to the office, as many careers and curricula now require field work. This is especially true for the sciences (Kent et al., 1997; Smith, 2004; Whitmeyer and Mogt, 2009), where mobile devices are becoming increasingly used for data collection. In field-intensive sciences, digital mapping technologies have revolutionised the ability of field teams and students to interact with each other during field work (e.g., Zook et al., 2010), to collect and archive data from multiple mappers (Whitmeyer et al., 2010; Whitmeyer, 2012), and to create more productive and meaningful shared learning experiences (Cochrane and Bateman, 2010; Pavlis et al., 2010; Whitmeyer and De Paor, 2014). Despite the ubiquity of smart devices and freely available, purpose-built mapping apps, their use in tertiary science classes remains limited (Welsh and France, 2012; Pavlis and Mason, 2017). As the workplace continues to evolve and these technologies become more and more integrated in employment, tertiary educators need to do more to integrate these technologies in their teaching practice in order to produce work-ready graduates.

Our 'overall aspiration' in the teaching framework, which is separate to the project aims, is to improve the intended learner outcomes using BYOD/WeBAD:

- Improve technological literacy
- Increase student engagement with peers and lecturers
- Improve sense of place and spatial awareness

Below, we discuss the guiding principles and critical elements that we hypothesized would lead to these outcomes. In doing so, we evaluate the evidence collected during this study and make recommendations for Tertiary educators.

Guiding Principles

(V) Enhance (not replace!) traditional field mapping methods

Background

Preliminary consultation with Geology academics raised the concern that digital mapping on devices would interfere with or detract from tried-and-true mapping skills (e.g., taking notes in a field notebook, drawing geological units on the map, and triangulating your position using landmarks). To address this concern, we chose an app that is not discipline-specific and emphasised to students how and when to use their devices to minimise overlap between traditional field gear and digital media. We included components in the device that reminded students of the key data they were to collect manually, rather than provided the means to do so within the app.

The app we settled on was *ArcCollector*, which is an ESRI product designed to work seamlessly with industry standard desktop software *ArcGIS*. ArcCollector is a data collection app that works by displaying geospatial information and storing GPS-tagged information in the field. Our decision to use this app over a range of others was based on the following rationale:

- Not discipline specific (i.e. could be used for field work in human geography, environmental science, biology, etc.)
- Ability to sync to an online interface
- Ability to customise basemaps, symbols, pre-coded notes, etc.
- Widespread usage of ESRI ArcGIS products in industry
- Ability to link to external GPS antennae for research grade mapping

Survey Results

We tailored the kinds of data students could collect for each course. Across all of the courses surveyed, the overwhelming majority of students agreed or strongly agreed that ArcCollector was useful for collecting data in the field (85%; Appendix 1). Two thirds agreed or strongly agreed that the data they collected on the app was useful for completing their final projects – though the degree to which the data was used out of the field varied significantly between classes.

Staff feedback

From your perspective, were there benefits of students using ArcCollector as a supplement to traditional methods in the field? If so, what were they?

- "Definitely, compared to previous years with no ArcCollector students could locate themselves better on their analogue maps from using ArcCollector. They could also locate themselves quicker so being able to spend more on higher level geological understanding."
- "They helped a LOT in student's ability to locate themselves. It also prompted them to take more photos of the outcrops."

From your perspective were there drawbacks of students using ArcCollector as a supplement to traditional data collection methods in the field? If so, what were they?

- "I guess potentially if the systems failed the students may have been reliant on the devices for location rather than analogue methods (I forgot to force analogue as well as arc collector location methods in the field)."
- "Any drawbacks were just around using the tablets in the rain. I didn't think there were any real drawbacks."

Other feedback

Several write-in comments on student surveys provided additional feedback:

- "Was very helpful on the GEOL240 trip [for] locating previous outcrops"
- "The app was used to mark locations and outcrops on the downloaded map as well as the ability to add notes and photos which was useful for future reference"
- "I would definitely use a device, being able to find your location accurately on the GPS made finding where we were very easy in places with little landmarks"
- "there wasn't an easy way to take detailed notes on my device through the app"
- "there wasn't an easy way to...relate [notes on my phone] to something I have taken notes on in my notebook"
- "takes some time to enter data, especially in a class setting"
- "wish I could write more"
- "when I returned to my notes after the trip, I realised that I had ignored taking notes in my field notebook"
- "the device was useful for pictures, but useless for notetaking"

- We also received some informal feedback that using the app was a good training tool for locating one's position on the map.

Recommendations

- Keep data collection on the device simple: GPS points, Geotagged photos, an open text field, and limited pre-coded notes are the most successful.
- Draw a firm line between expectations for manual and digital note taking
- Remind students how data stored on the device will be used – is it just for field reference or data analysis later on? How will it help them in assessments?

(VI) Produce workplace-ready graduates

Background

One of the guiding principles of this project is to prepare students for skills they will need in the workplace. This is part of New Zealand's Tertiary Education Strategy ("Delivering Skills for Industry") and the University of Canterbury's Graduate Attribute Profile ("Employability, innovation, and enterprise"). We envisioned that BYOD addresses these in two ways:

- By providing familiarity with modern data collection techniques, using industry standard software, in a team environment (via ArcGIS and ArcCollector)
- By providing a means for spatial data analysis (via ArcGIS Online)

Survey Results

There were small improvements post-field trip in students being comfortable using GPS (marginal increases in number of agree/strongly agree and marginal decreases in number of disagree/strongly disagree; Appendix 1).

Recommendations

- While we do not have data from graduates, we know that employers and graduates are relying more on technology like GPS for field work. It would be useful for educators to consult employers and use the info to tailor the content in ArcCollector.

- Use the data stored in ArcCollector to sync to ArcGIS Online: allow the students to work with the wealth of data in the classroom (see *Teacher Intentions* section), especially with quantitative data.

(VII) Enhance the student experience: community mapping and (VIII) Control the learning process: community mapping

Background

Field trips are most effective when they are fun and provide a *sense of place* to students (Jolley et al., 2018). The latter can be difficult in large field areas or field trips consisting of multiple, disconnected, and/or roadside stops. This app provides a fun, easy, visual method to (i) keep track of the regional context of the fieldwork, (ii) encourage a sense of exploration, (iii) foster an in-field instructor-student learning community (e.g. Jolley et al., 2018).

Peer teaching is an effective tool in any environment. Because students have the opportunity to sync their data to master datasets in ArcCollector, the entire class is privy to a wealth of peer data and observations. The app also makes it easy to share the location of geotagged photos and videos on the fly (i.e. without syncing data).

Staff feedback

Did students use the data stored on ArcCollector to engage peers with their observations?

- “Yes, they showed photos to each other.”
- “Yes”

Do you plan to continue using ArcCollector in your courses? Please explain.

- Yes please. I would also like to add it to my 3rd year fieldtrip since it’s even harder to keep track of where you are over the days on that trip.

Other feedback

- Some staff observed students discussing their mapping and planned routes using the ArcCollector app, both with demonstrators and other students.
- Two students who could not attend the one-day field trip were able to watch geotagged videos of lectures and follow sync’d peer data of the

trip. Some students found it useful to review peer data and lectures in ArcGIS online despite having attended on the day.

Recommendations

1. Geotagged photos are key and the main source of interaction with others on field trips.
2. Provide maps and layers in the app that provide students regional context as well as site-specific details
3. Provide layers that give students broader cultural and historical context outside of the intended curriculum
4. Encourage all students, demonstrators, and lecturers to use BYOD – requires buy-in from staff
5. Lecturers should model behaviour of using the app to discuss existing data and mapping strategies
6. The app and online interface (ArcGIS Online) can be used as field trip review upon trip conclusion

(IX) Control the learning environment: support learning objectives

Background

The customisable features and layers in the app can be used to reinforce learning objectives. For example, one of the major challenges in field geology classes is overcoming a steep learning curve of recalling all of the new types of data you are required to collect at every outcrop: location, rock type, sedimentary structures, orientation of bedding, weathering characteristics, contacts, foliation, etc. This can be overwhelming for students, especially in the context of having limited time for a first-time mapping assignment.

One successful approach was providing students a drop-down menu of the key data they had to collect at each site. In geology, we encourage students to collect the actual data in field notebooks, but ‘digital reminders’ stored within the app can be useful.

Having digital content stored within the app also presents the opportunity to provide students with multiple layers of GIS information. In geology, this means that while students are mapping on aerial photos of an area, they can check their location against other basemaps (e.g. topographic maps, hillshade models, existing geologic maps), GIS features (e.g., land use and property boundaries, fences, cultural landmarks), and other student data. In cases where the geology directly influences things like vegetation, or locations of springs, for example, these datasets provide meaningful insights into ‘why geology matters’.

Other feedback

- Staff on one trip used ArcCollector to provide useful hints to students about the mapping area, including hazards and routes to take through difficult terrain.

Recommendations

1. Provide 'digital reminders' stored within the app to assist teaching and support learning objectives
2. Provide a range of interdisciplinary GIS data to give context to the science

Critical Elements

(X) Nuts and Bolts (device hardware and apps)

Background

We considered a range of apps to use in this project. We settled on the ArcCollector app because it is versatile and customisable for a range of uses outside of purpose-built Geology apps, for example. ESRI (owner of ArcGIS software) has an overview of the hardware requirements along with other resources and tutorials for this app here.

Nicolas Barth of University of California Riverside has an excellent review of different software/hardware combinations for field mapping if there is interest in using other systems.

Because this is mostly a BYOD programme, it introduced the risk of excluding students who do not have devices or compatible devices. To address this important issue, we bought 10 field-ready, ArcCollector-compatible tablets for students and lecturers/demonstrators. In the process, we evaluated whether there was a preference for being provided a department device versus BYOD.

Student survey

Results of BYOD-only versus WeBAD (i.e., courses in which department devices were available) course survey data can be found in Appendix 2. The most notable difference is in the response to the statement "The level of pre-trip training was sufficient for using ArcCollector in the field": far more positive responses were recorded for Department-Device Available courses, probably because these were pre-loaded with maps and had larger screens for easy operability.

Staff feedback

From your perspective, were there drawbacks of students using their own device for field data collection? If so, what were they?

- “The quality of the device matters a LOT. Also, the maps aren’t preloaded, and some students give up using their own device because remembering to download the map each morning is hit or miss. Also, the amount of memory available is variable and some of the devices crash once students start to overload them with photos.”
- “Battery usage always comes up as a limitation from students, but the majority like to use their own phones for familiarity and being able to have their data and photos.”

Other feedback

Would you prefer to use your own device, someone else’s, or none at all for future field work? Please explain.

- Support for BYOD (samples):
    - “I liked using my device because it gave me a clear idea as to where my images were along the trip”
    - “my own-for reasons of familiarity”
    - “own device-it is useful to have no admin in accessing the data collected”
    - “my own- I’d prefer not to sync data to prevent over-clustering field data”
    - “own-easy to follow and update later on”
    - “own device: familiar setup and easier to access data later on”
    - “my own- I know how it works, less things to carry”
    - “my own so I could refer back to info more easily”
    - “my own device as that’ll be the easiest to translate data”
    - “Able to target better, don’t have to necessarily share [data] and have more control, more familiarity, more familiar, knew how to use it, easy access and know how to use”
    - “I would like to use my own. As soon as teammates start logging it makes it more confusing to follow”

- Support for Department-Provided-Device (samples):
    - "someone else's with bigger screen"
    - "Prefer department device. Larger screen."
    - "Battery life of phone is no good for the app. Using department tablet, never ran out."
    - "Departmental device as they are designed for field work and I don't have to spend $$ on one myself"
    - "The weatherproofed tablets we were provided by the department were much more preferable over personal devices for both durability and digital storage space."
    - "Departments - waterproof and shockproof. Not a fan of the large/bulky size."
    - "as we were working in snow and ice 14environments, our device got wet and therefore didn't work that well"

- Support for no device
    - "I find it easy using no device because carrying a device in the field can be an inconvenience."

Recommendations

- Make resources available for BYOD and a fleet of field tablets and let the students choose which they prefer. The ideal device will vary based on individual needs and the nature of the coursework.
- If students have not been trained to download the data onto their own devices, we have noted there is the risk they will give up on the app altogether. Providing a device with preloaded maps works around this problem.

(XI) GIS Administration

Background

This system requires an organisational account with ArcGIS Online and, in part, on available credits for hosting content online. We expect most tertiary institutions with a geology or geography programme will have this. In our case, we also have a GIS administrator and technicians that perform the following functions, allowing the field work to run smoothly:

- Manages students' accounts for each course (e.g., adding/deleting from course, managing access)
- Technical support for interface between ArcGIS Online and ArcCollector
- Teaching support for student training

These functions can be performed by teaching staff but are time-intensive and more appropriately dealt with by a GIS specialist/technician.

Staff feedback and workshopping

One important decision to be made is how to organise accounts for ArcCollector. Is there one account for all students in the course, meaning that all data will be synced a class-wide dataset? Does each student have an account, and, is that account per course or over the tenure of their undergraduate degrees? We envision that the preference will vary by academic programme, but the best options seem to be:

i. A class-wide account that can be used by all students in the course. This has the benefit of being low maintenance, and automatically compiles all synced data into one dataset. One teacher noted, "I was really pleased with the way the pooled resources worked for the final assignments in GEOG211 - it was great for those students that did have issues." The drawback is that students who prefer only their own data cannot sync during or after data collection;
ii. Individual accounts for students, on a course-by-course basis. This has the benefit of each student maintaining their own data if they choose, but is a higher administrative load to create and delete accounts;
iii. 'Portfolio' accounts for students, for all of their courses. This has the benefit of creating a digital archive of their field work throughout their degree but takes a lot of storage space and would not be recommended for accounts with limited credits.

Recommendations

- GIS administration is essential and best serviced by a GIS or computer technician.
- Consider the best system for creating, maintaining, and curating student accounts – the best system will vary based on the programme.

(XII) Teacher Skills

Background

Teachers need to know how the app works, common errors, how to prepare the content used in the app, and how to download and manage all of the data that is collected. This requires a non-trivial amount of time and training. Fortunately, ArcGIS provides useful resources for both upstream (ArcGIS and ArcGIS Online) and downstream (app) components (see Section X).

Staff feedback and workshopping

When asked about uses and challenges of the app, one teacher noted,

> "…One thing about ArcCollector is that when you sync the data it is not clear that it has actually worked. On our… devices it keeps displaying as if the data had not been synced, and then when you try to do it again you get an error message. So I think including the sync in the practice run and getting the students to check their data is there on Arc Online would help with confidence in this…It is a bit stressful from a teaching perspective when you are in the field to know that a chunk of the assignment data is reliant on technology! But it worked."

Other feedback

- "Lecturers/tutors were not familiar with ArcCollector" –Student

Recommendations

- The teaching team needs to be trained to deal with issues at a minimum and, ideally, actively using the system on field trips.
- If using the data after the field trip, having a group 'syncing' session with the GIS administrator is a useful way to identify and address syncing problems.

(XIII) Evidence-informed practice

This report forms one basis for evidence-informed practice, but we encourage educators to constantly monitor and adjust based on (i) feedback from students and/or (ii) user data maintained in ArcGIS Online. How are the students using the content provided to them? How many individuals contributed to the group 'sync'd' data? Did they find the field data useful?

(XIV) Teacher intentions

Background

Teachers need to spend time planning how this BYOD programme will be constructively aligned in the curriculum and used strategically to achieve the course and programme intended learning outcomes. Is BYOD just a novelty, or another tool-of-the-trade? Can it build on concepts explored in class? How does the app content help the student learn?

We have considered two primary ways in which BYOD can be integrated into a course: (i) an optional GPS supplement to field mapping, and (ii) a required method for quantitative data collection. Anecdotally, (i) seems to have worked better in field geologic mapping, where students independently map large areas and are expected to synthesize a wide range of geologic data (structural, lithologic, geomorphic, etc.) on maps and in field notebooks; (ii) seems to have worked better for specific research projects and semi-quantitative or quantitative data collection, where all of the data can be standardised across devices and students.

Student survey data

In a comparison between a research-focused class (blue series, Fig. 2), a field mapping project (grey series), and all classes surveyed (orange series), there was a ~15% increase in students agreeing that the data in ArcCollector were useful for their final projects. A commensurate decrease in students responding 'Neutral' was observed. The research-focused class had custom features and basemaps tailored to the specific research project at hand (i.e., taking measurements on rockfall boulders in this case).

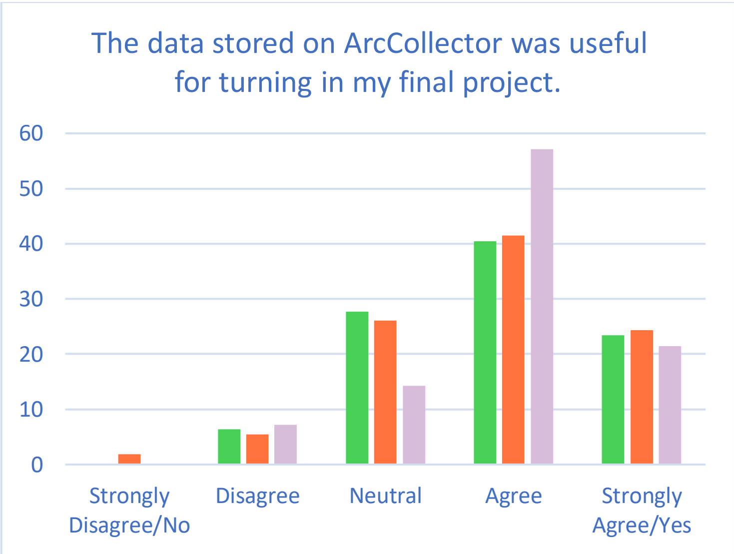


Figure 2: Comparison of student responses from two classes compared to all of the survey data collected (orange). Grey series was independent field mapping whereas the blue series was data collection for undergraduate research. Y-axis is percentage of responses.

Staff feedback and workshopping

- "My feeling is that if we are getting them to use this, then it should have a purpose i.e. be linked in some way to their reports/assignments otherwise it could come across as just a gimmick – it is either beneficial to learning or not"

Recommendations

- The data collected on devices should always be used to support learning and should therefore be part of the assessment structure of the course. However, there are direct and indirect ways to integrate BYOD into the classes depending on the nature of the field work. Once again, careful consideration of the course's intended learning outcomes, and the role BYOD plays in achieving those outcomes, is crucial.

(XV) Student training

Background

Some training prior to going into the field is critical to the success of BYOD. Students need to know how to log in to ArcCollector, download data and map areas, and collect/delete/sync features. If this is left until being in the field, cognitive overload will be too much, and students will disengage.

One idea that has been successful in Geology courses is the 'scavenger hunt' model of training, built into an orienteering training exercise. In this exercise, students were provided content on the app that indicated the locations of checkpoints around the university campus. Students navigated to these positions, collected a geotagged photo of them collecting the reward, collected a basic GPS point and description of the site, then synced the data in real time back to the instructor in the classroom.

Student survey data

We asked students after the trip whether they thought the level of training was sufficient (Appendix 1). Though the commitment to training students varied by course and teacher, overall, 72% of students agreed or strongly agreed that the training was sufficient. Nearly 80% of students agreed or strongly agreed that ArcCollector was easy to use.

Staff feedback

Did students have an adequate level of training to use ArcCollector in the field?

- "Although the students seems to indicate that they were happy with the training provided pre-trip, my thoughts are that I should do a more explicit lab where we load the app onto their phones take some data and then sync it and look at it in ArcGIS online….A full practice run may have helped with some of the issues and would have just made the students slicker in the field – although most were really great."
- "Since we used only the most basic functions, all our students did fine. I didn't notice anyone who had problems."

Other feedback

- Prior to the trip, we asked students what experience they had with GPS. While analysis is ongoing to account for prior usage of this app in other courses, a common response was that students have used GPS for navigation and/or recreation.
- Some students indicated that due to frustration with downloading the maps, even with training, they gave up on the system altogether.

Recommendations

- Dedicate a lab session to familiarising students and staff with ArcCollector (i.e. downloading maps, collecting data, syncing data).
- Keep maps simple: 1-2 basemaps, and a few editable feature classes.

(XVI) Pre-field preparation

Recommendations

This is partially linked to the two previous elements, but with a more practical note: ensure that students download content to their devices and collect 'dummy' data prior to going into the field. Educators need to allow time, prior to the day of departure, to fix student and software errors. Also, if there are multiple streams of the same class being run, and students are using classroom accounts, consider how to manage data from the past stream – will someone manually delete all of the first stream's data?

Summary of Recommendations

Recommendations to students

1. Focus on simple data collection (GPS points, geotagged photos, open text fields, and limited pre-coded notes). Reserve detailed notetaking for the field notebook.
2. Use the data stored in ArcCollector to sync to ArcGIS Online: allow the students to work with the wealth of data in the classroom (see *Teacher Intentions* section), especially with quantitative data.
3. Make sure your device, app, and maps work well before heading out into the field.

Recommendations to staff and demonstrators

1. Prevent cognitive overload with simple training exercises and pre-field preparation (such as including 1 to 2 pre-loaded maps and a few editable feature classes) in advance of the field trip. Dedicate a lab session to familiarising students and staff with ArcCollector (i.e. downloading maps, collecting data, syncing data). Ensure that students download content to their devices and collect 'dummy' data prior to going into the field.
2. Provide a range of interdisciplinary GIS data to give context to the science. These datasets can also provide meaningful insights into 'why geology matters' by noting how geology directly influences surrounding vegetation and location of springs for example. Layers can be used to expand beyond the curriculum to include a broader cultural and historical context.
3. Provide useful hints to students about the mapping area, including hazards and routes to take through difficult terrain. Make use of 'digital reminders' to support learning objectives.
4. Encourage geotagged photo-taking as it greatly facilitates interaction with others on fieldtrips.
5. Consider the best system for creating, maintaining, and curating student accounts. Remind students how data stored on the device will be used – is it just for field reference or data analysis later on? How will it help them in assessments?
6. Encourage staff and students to use BYOD (requires buy-in from staff). Lecturers should model behaviour of using the app to discuss existing data and mapping strategies.
7. Make 'WeBAD' an option – device quality and preferences will vary widely among students.
8. The teaching team needs to be trained to deal with issues at a minimum and, ideally, actively using the system on field trips. Educators need to allow time, prior to the day of departure, to fix student and software errors.
9. If there are multiple streams of the same class being run, and students are using classroom accounts, consider how to manage data from the past stream – will

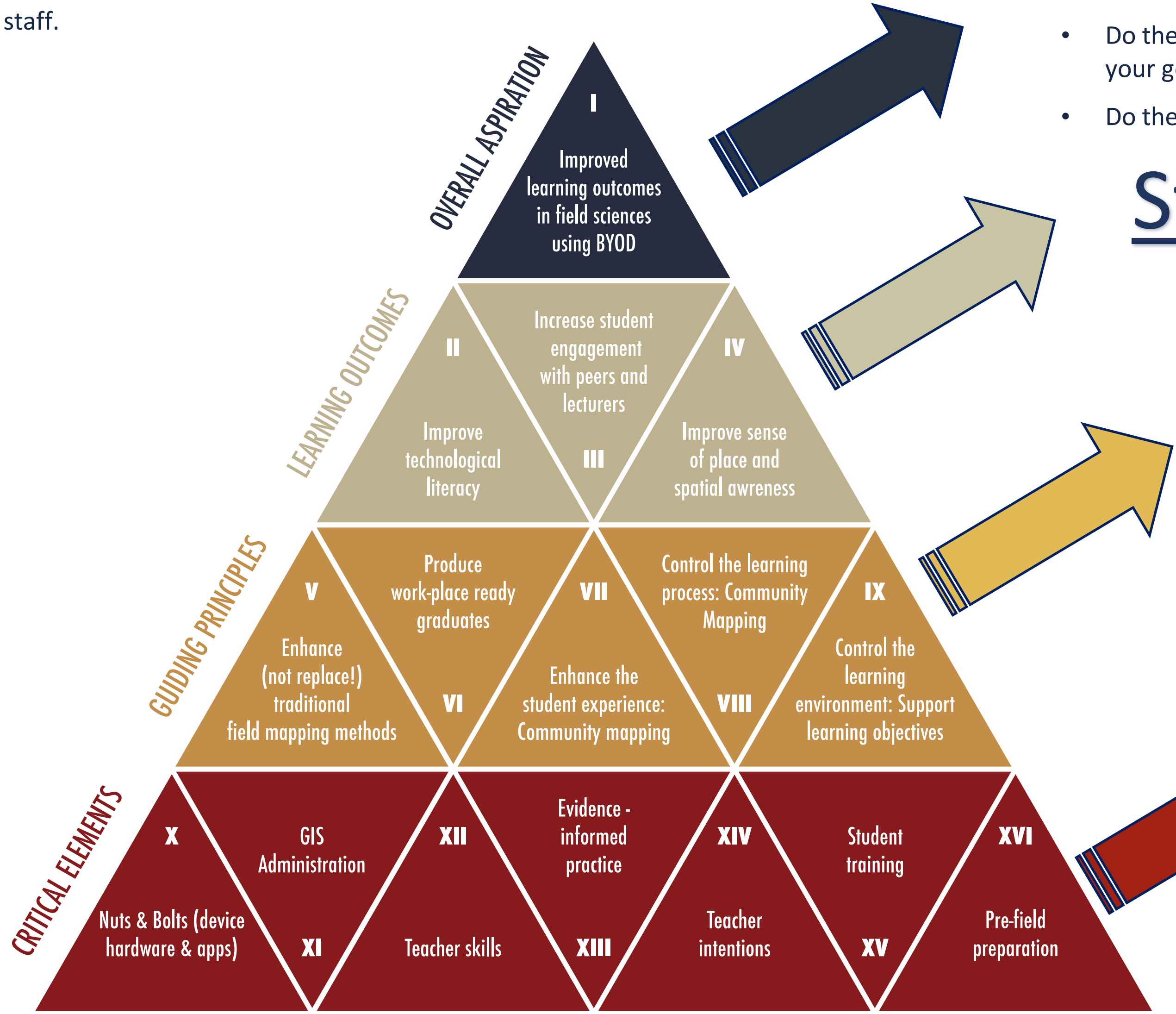
someone manually delete all of the first stream's data? If using the data after the field trip, having a group 'syncing' session with the GIS administrator is a useful way to identify and address syncing problems.

10. As the industry relies on technology like GPS for field work more, educators can consult employers to tailor content in the ArcCollector to make it more relevant for students.

Concluding thoughts on workflow

Armed with this information, how does one actually go about using this information? While we will cover this section in more detail in the video series, the schematic below is intended to help guide educators in their decision-making process.

Figure 3: The BYOD/ WeBAD Teaching Framework mapped to 'guiding questions' and a recommended workflow for teaching staff.



Step 1: Decide

- Do you have the time and resources required?
- Do the learner outcomes, principles, and aspiration map well to your goals?
- Do the benefits outweigh the time commitment?

Step 2: Plan

- BYOD-only, WeBAD, or both?
- Devices used as field supplement or detailed data collection tool?
- How will data be used after the trip?
- How will student ArcGIS accounts be managed?
- How will you design your training exercise?
- Are you leaving enough time prior to the real trip for preparation?
- Can you effectively troubleshoot common tech problems?

Step 3: Analyse

- Sync student data
- Work with student data (e.g. spatial analysis, trip summary report, or virtual fieldtrip production)
- Assess student projects and work feedback into subsequent courses

Bibliography and Useful References

Cochrane, T., and Bateman, R. (2010). Smartphones give you wings: pedagogical affordances of mobile Web 2.0. *Australasian Journal of Educational Technology, 26*(1), 1-14.

Fuller, I., Brook, M., and Holt, K. (2010). Linking teaching and research in undergraduate geography papers: the role of fieldwork. *New Zealand Geographer 66*, 196-202.

Jolley, A.R. (2017). *Student experience and sense of place on geoscience field trips.* PhD dissertation, University of Canterbury.

Jolley, A.R., Kennedy, B.M., Brogt, E., Hampton, S.J., and Fraser, L. (2018). Are we there yet? Sense of place and the student experience on roadside and situated geology field trips. *Geosphere, 14* (2), 651-667. doi: https://doi.org/10.1130/GES01484.1

Kent, M., Gilbertson, D., and Hunt, C. (1997). Fieldwork in geography teaching: a critical review of the literature and approaches. *Journal of Geography in Higher Education, 21*(3), 313-332.

Pavlis, T.L., Langford, R., Hurtado, J., and Serpa, L. (2010). Computer-based data acquisition and visualization systems in field geology: Results from 12 years of experimentation and future potential. *Geosphere 6*(3), 275-294.

Pavlis, T.L., and Mason, K.A. (2017). The new world of 3D geologic mapping. *GSA Today, 27*: doi: 10.1130/GSATG313A.1.

Smith, D. (2004). Issues and trends in higher education biology fieldwork. *Journal of Biological Education*, *39*(1), 6-10.

Welsh, K. and France, D. (2012). Smartphones and fieldwork. *Geography, 97*(1), 47-51.

Welsh, K., France, D., Whalley, W.B., and Park, J.R. (2012). Geotagging photographs in student fieldwork. *Journal of Geography in Higher Education, 36*(3), 469-480.

Whitmeyer, S.J., and Mogk, D.W. (2009). Geoscience field education: a recent resurgence*. EOS Transactions American Geophysical Union*, *90*(43), 385-386.

Whitmeyer, S.J., Nicoletti, J., and De Paor, D.G., (2010). The digital revolution in geologic mapping: *GSA Today, 20*(4/5), 4-10.

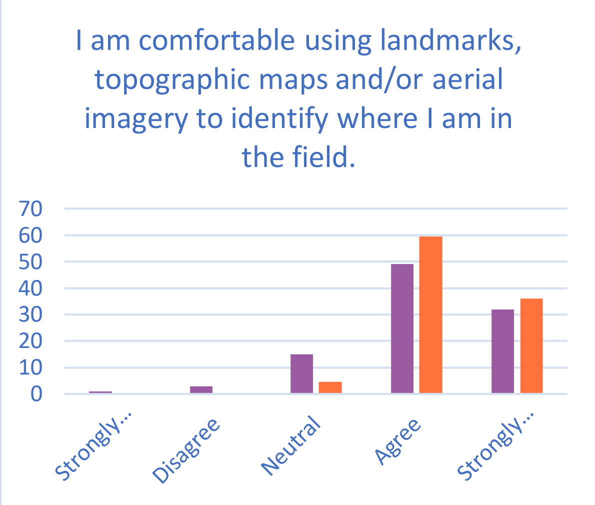
Whitmeyer, S.J. (2012). Community mapping in geology education and research: How digital field methods empower student creation of accurate geologic maps. *Geological Society of America Special Paper, 486*, 171-174.

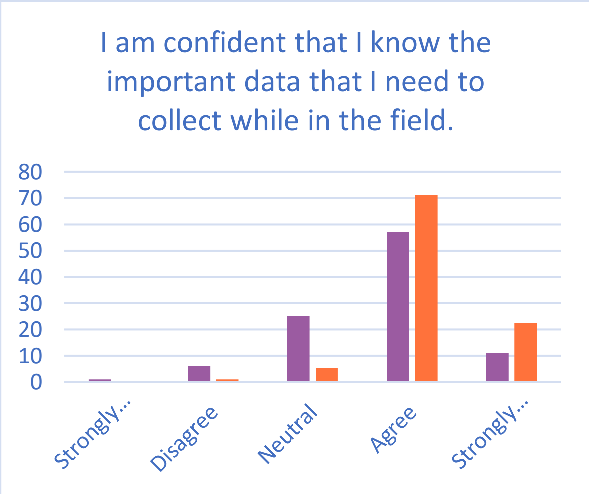
Whitmeyer, S.J., and De Paor, D.G. (2014). Crowdsourcing Digital Maps Using Citizen Geologists. *EOS 94*(44), 397-399.

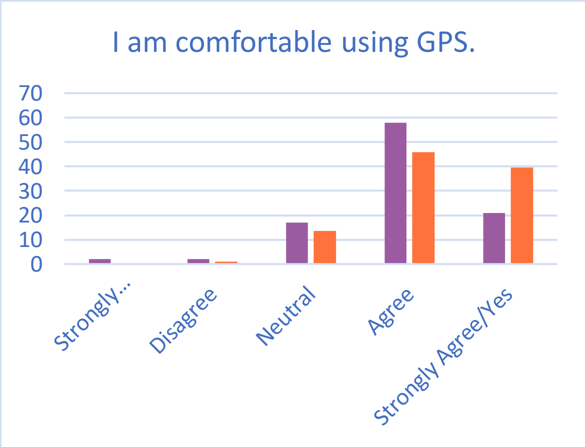
Zook, M., Graham, M., Shelton, T., and Gorman, S. (2010). Volunteered geographic information and crowdsourcing disaster relief: A case study of the Haitian earthquake: *World Medical Health Policy, 2*, 7-33.

Appendix 1: Survey data from all courses

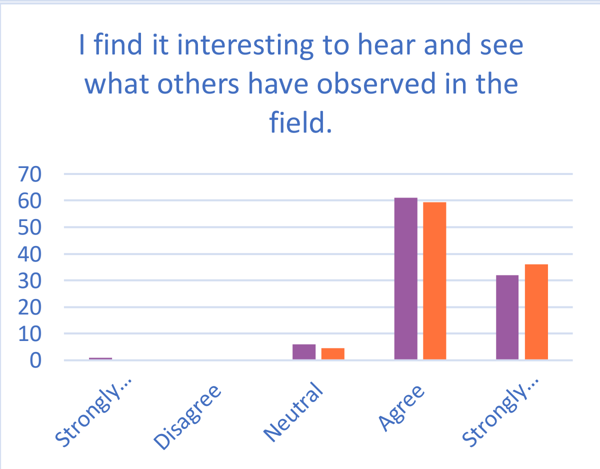
Each question or statement is presented at the top of the graph. Values are expressed as percentages (y-axis) to normalise for number of respondents before and after the trip. Pre-trip respondents (blue)=100. Post-trip respondents (orange) = 111. Where students left a question blank, we recorded that as "Blank".

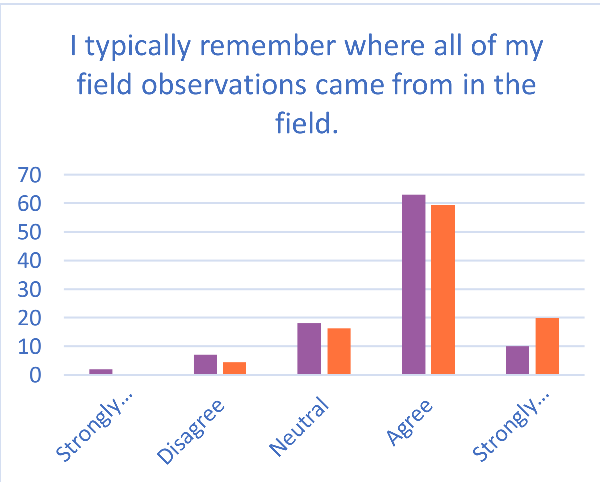






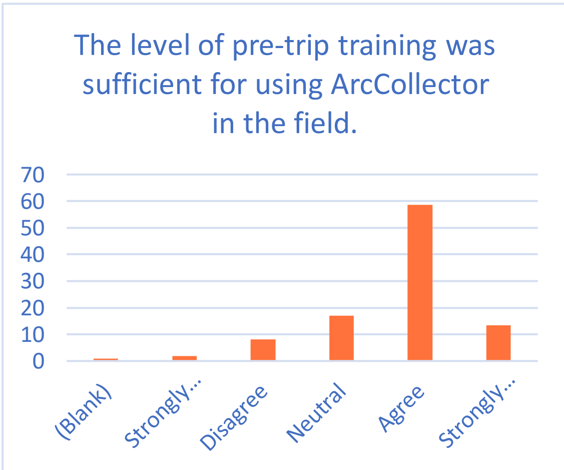

When others talk about what they observed in the field, I find it easy to follow their descriptions.
70
60
50
40
30
20
10
0
Strongly...
Disagree
Neutral
Agree
Strongly Agree/Yes

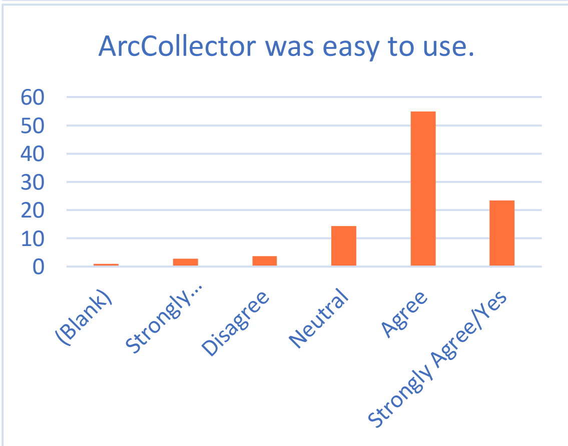

I find it interesting to hear and see what others have observed in the field.
70
60
50
40
30
20
10
0
Strongly...
Disagree
Neutral
Agree
Strongly...

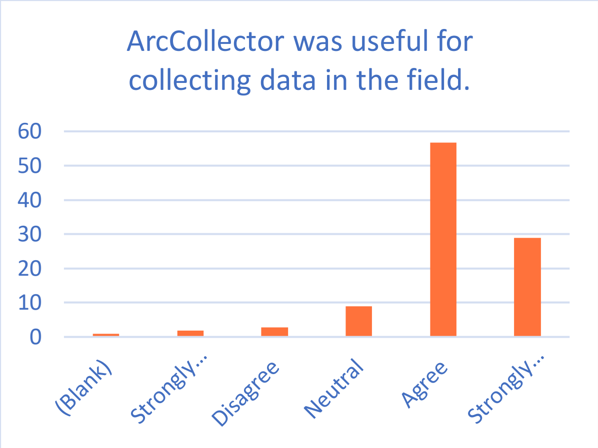

I typically remember where all of my field observations came from in the field.
70
60
50
40
30
20
10
0
Strongly...
Disagree
Neutral
Agree
Strongly...

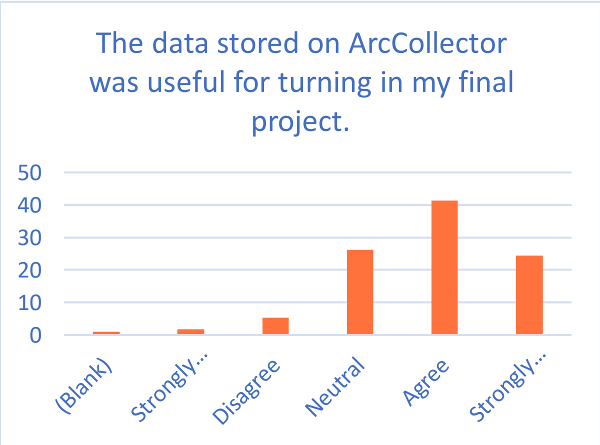

I can keep track of everywhere I have been in the field.
60
50
40
30
20
10
0
Strongly...
Disagree
Neutral
Agree
Strongly...


I find it easy to communicate what I have observed in the field to others.
70
60
50
40
30
20
10
0
Strongly...
Disagree
Neutral
Agree
Strongly...


The level of pre-trip training was sufficient for using ArcCollector in the field.
70
60
50
40
30
20
10
0
(Blank)
Strongly...
Disagree
Neutral
Agree
Strongly...


ArcCollector was easy to use.
60
50
40
30
20
10
0
(Blank)
Strongly...
Disagree
Neutral
Agree
Strongly Agree/Yes


ArcCollector was useful for collecting data in the field.
60
50
40
30
20
10
0
(Blank)
Strongly...
Disagree
Neutral
Agree
Strongly...

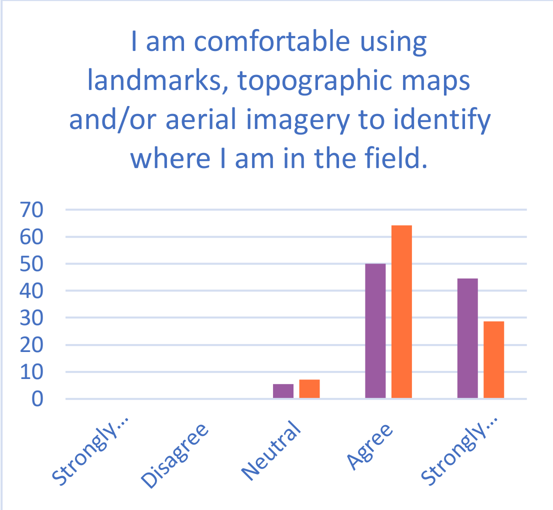

The data stored on ArcCollector was useful for turning in my final project.
50
40
30
20
10
0
(Blank)
Strongly...
Disagree
Neutral
Agree
Strongly...

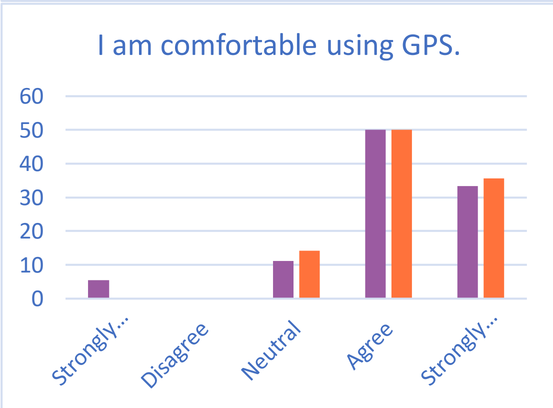
Appendix 2: Survey data by BYOD or Device-Provided

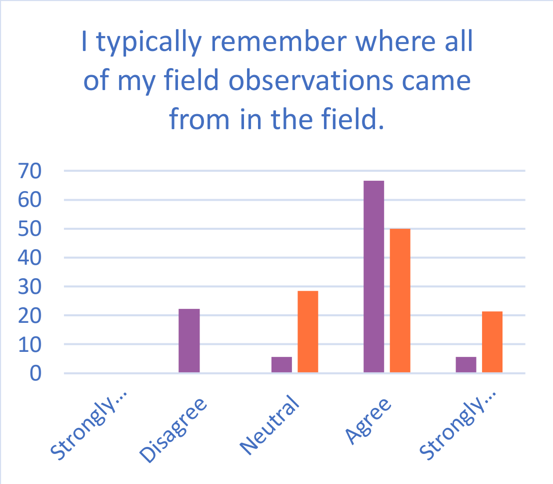
Each question or statement is presented at the top of the graph. Values are expressed as percentages (y-axis) to normalise for number of respondents before and after the trip. Pre-trip respondents (blue)=100. Post-trip respondents (orange) = 111. Where students left a question blank, we recorded that as “Blank”.

(2A) BYOD Only (no department device option)

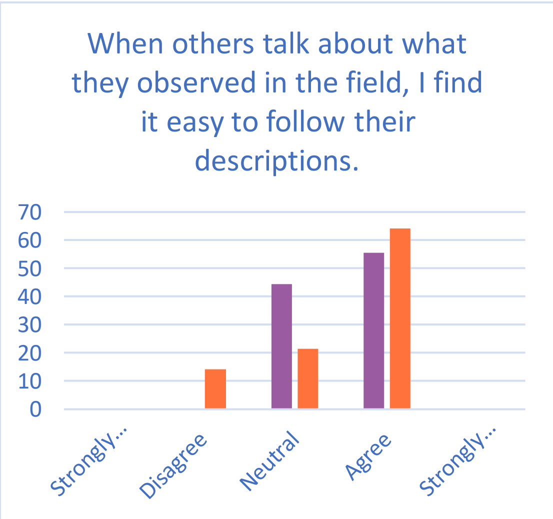
Pre-trip respondents=18 (blue). Post-trip respondents (orange) = 14.



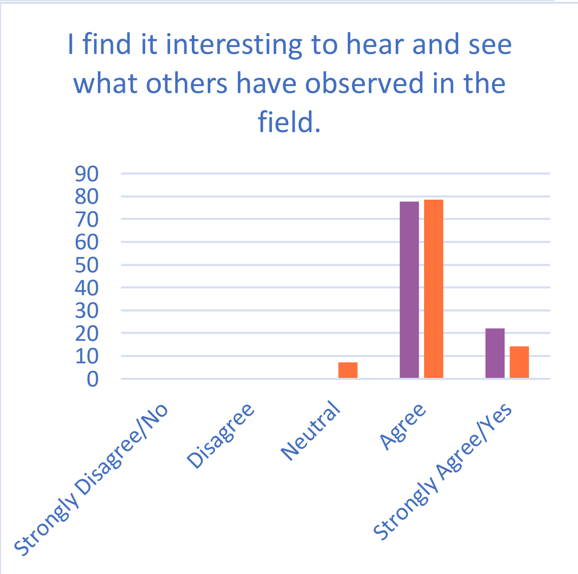


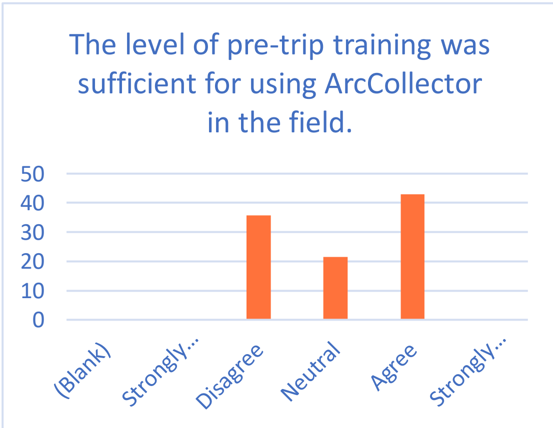

I typically remember where all of my field observations came from in the field.
70
60
50
40
30
20
10
0
Strongly...
Disagree
Neutral
Agree
Strongly...

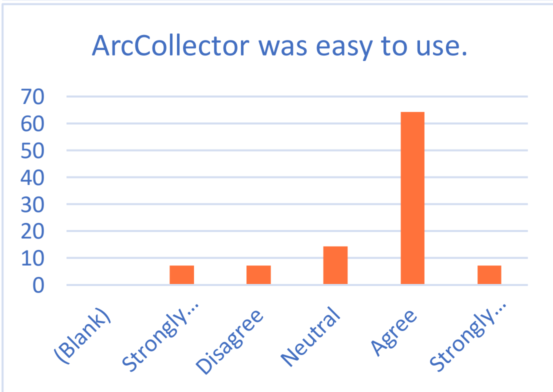

I can keep track of everywhere I have been in the field.
80
70
60
50
40
30
20
10
0
Strongly...
Disagree
Neutral
Agree
Strongly...

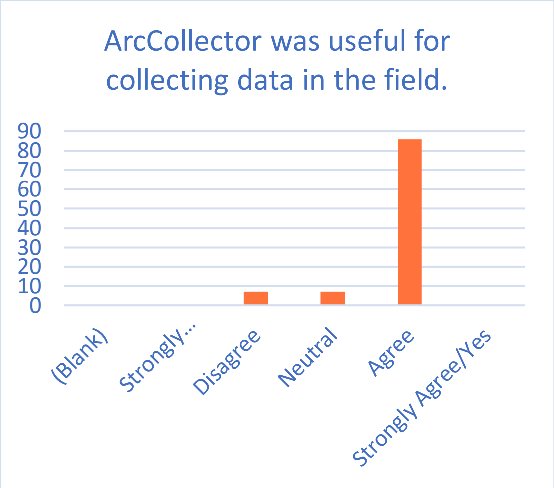

When others talk about what they observed in the field, I find it easy to follow their descriptions.
70
60
50
40
30
20
10
0
Strongly...
Disagree
Neutral
Agree
Strongly...

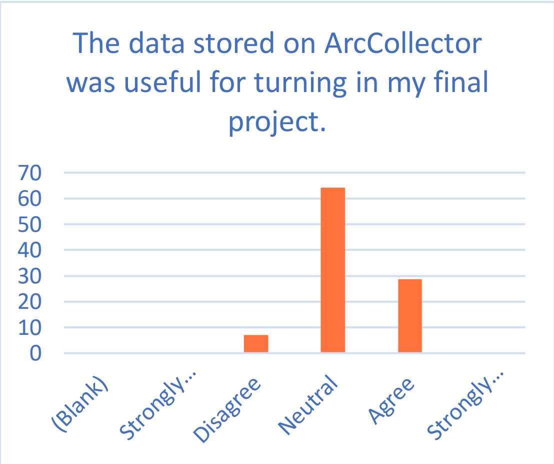

I find it easy to communicate what I have observed in the field to others.
80
70
60
50
40
30
20
10
0
Strongly...
Disagree
Neutral
Agree
Strongly Agree/Yes


I find it interesting to hear and see what others have observed in the field.
90
80
70
60
50
40
30
20
10
0
Strongly Disagree/No
Disagree
Neutral
Agree
Strongly Agree/Yes


The level of pre-trip training was sufficient for using ArcCollector in the field.
50
40
30
20
10
0
(Blank)
Strongly...
Disagree
Neutral
Agree
Strongly...

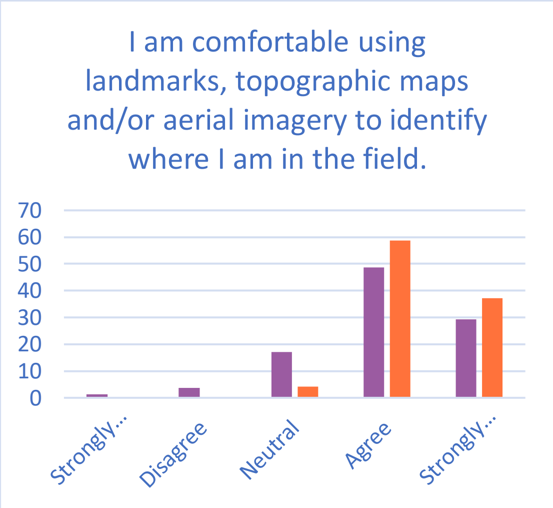

ArcCollector was easy to use.
70
60
50
40
30
20
10
0
(Blank)
Strongly...
Disagree
Neutral
Agree
Strongly...

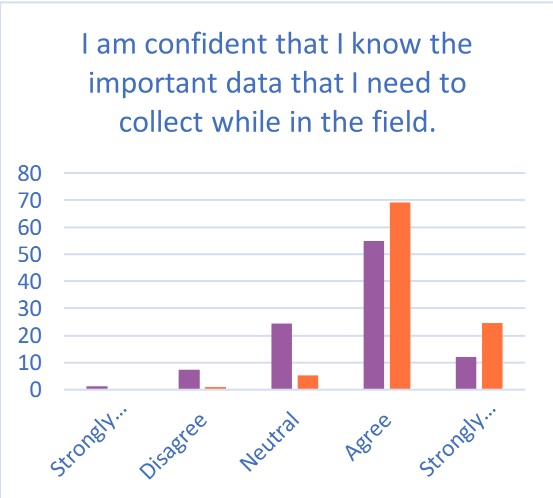

ArcCollector was useful for collecting data in the field.
90
80
70
60
50
40
30
20
10
0
(Blank)
Strongly...
Disagree
Neutral
Agree
Strongly Agree/Yes

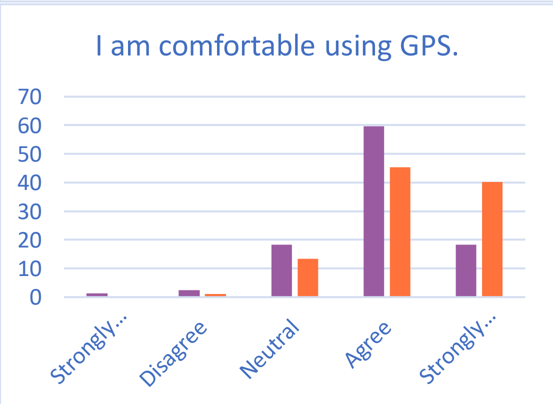

The data stored on ArcCollector was useful for turning in my final project.
70
60
50
40
30
20
10
0
(Blank)
Strongly...
Disagree
Neutral
Agree
Strongly...

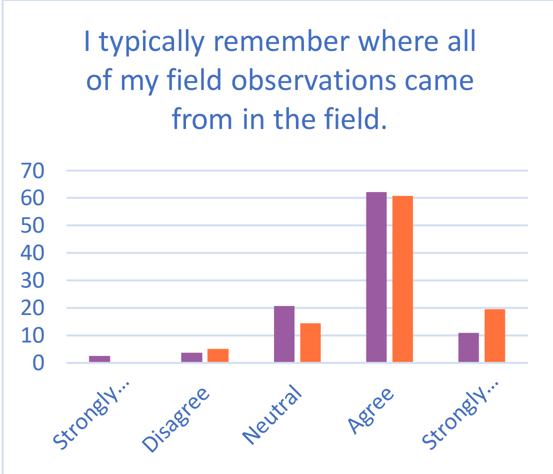
(2B) Department device required or available as option

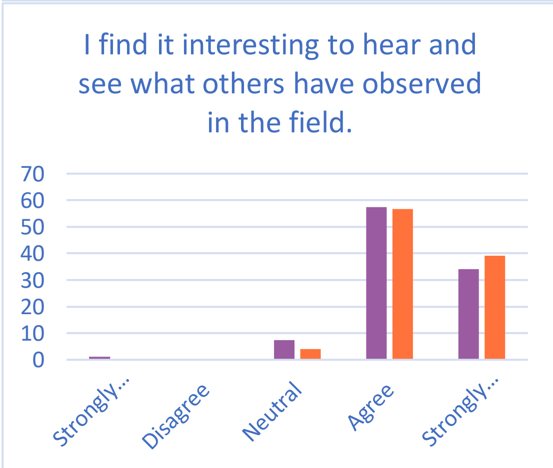
Pre-trip respondents=82. Post-trip respondents = 97.



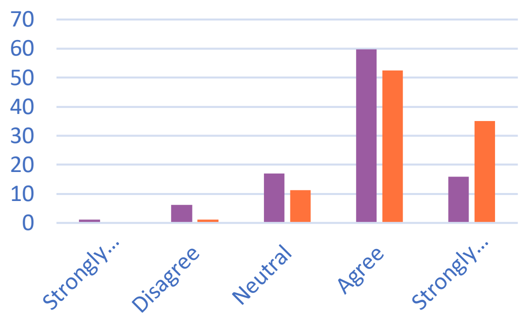




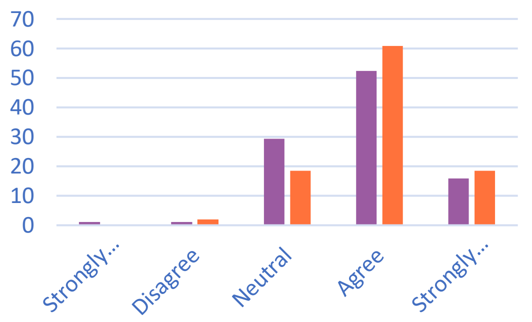




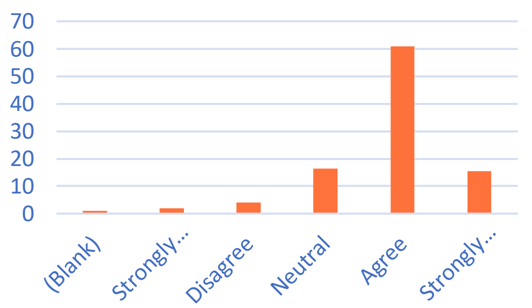
I can keep track of everywhere I have been in the field.



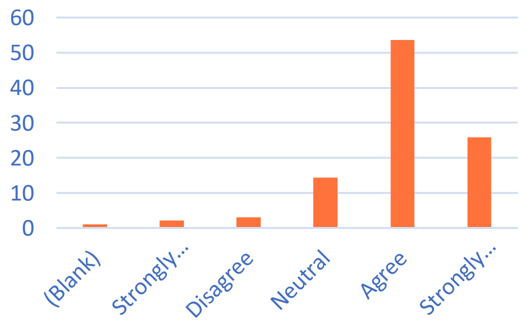
I find it easy to communicate what I have observed in the field to others.



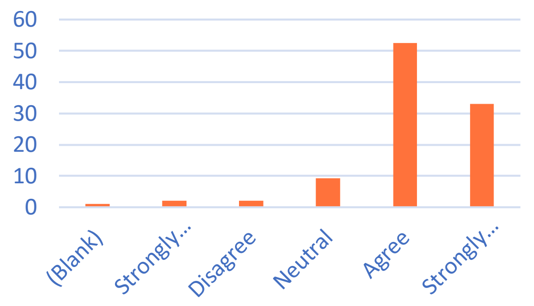
The level of pre-trip training was sufficient for using ArcCollector in the field.



ArcCollector was easy to use.



ArcCollector was useful for collecting data in the field.



The data stored on ArcCollector was useful for turning in my final project.