Integrating GIS in Experiential Fieldwork

Dr Sarah Digan
Geography teacher, Orana Steiner School, Canberra

Abstract

Digital technologies such as Geographic Information Systems (GIS) can be innovative tools for learning when used in purposeful ways and embedded in sound pedagogical frameworks. The predominant skills stimulated through the use of GIS are querying, collecting, analysing and manipulating spatial data. In recent years, the financial, technological and curricular hurdles for using GIS in schools have been reduced through free campus licences (e.g. Esri Australia), online apps and cloud-based mapping solutions (e.g. ArcGIS Online). Additionally, with the inclusion of GIS in the Australian Curriculum there is a need for specialised teacher training and in-service professional development to make GIS integral in the secondary school environment. In this paper, teaching units for Year 8 Geography using GIS in experiential fieldwork will be presented and evaluated in regard to their learning outcomes as examples of how to incorporate GIS into teaching episodes.

Introduction

In Australia, the implementation and use of Geographic Information Systems (GIS), or Geographic Information Science, in education has been emphasised through the integration of spatial technologies in the Australian Curriculum: Geography. In recent years, GIS has been promoted through freely available web-based or online resources (Abbey, 2017). In Years 7 and 8, the content descriptors of the Australian Curriculum: Geography broadly encourage the use of 'spatial technologies' to interpret and analyse geographical data under the strand of Geographic Inquiry Skills. In Years 9 and 10, the curriculum makes specific reference to GIS.

The benefits of using spatial technologies in the classroom have been widely studied (Demirci, Karaburun, & Ünlü, 2013; Jo, Hong, & Verma, 2016; Lee & Bednarz, 2009; Mzuza & Van Der Westhuizen, 2019) and include the enhancement of spatial thinking and reasoning skills and the use of GIS as a geographic inquiry tool. Considering the growing need for (spatial) data scientists (Delporte, 2018; Granville, 2014), another benefit of using GIS in teaching is to assist young Australians to develop skills needed for these roles.

There have been various efforts to implement GIS in the classroom, however, its use in some places still remains marginal (Höhnle, Fögele, Mehren, & Schubert, 2016). Some teachers lag behind in their knowledge, skills and experience with GIS (Collins & Mitchell, 2019; Höhnle et al., 2016; Mitchell & Lambert, 2015). This limits the implementation of meaningful and authentic GIS projects in schools and questions the achievability of meeting the Australian Curriculum standards for Geography in regard to spatial technologies. This may be a result of limited pre-service teacher training at university or a lack of professional development for in-service teachers. Short courses as part of professional development for in-service teachers should explore GIS software in adequate depth to enhance confidence. It is vital for teachers to have access to units and resources that introduce beginners to GIS. Readily-available teaching units can be an important incentive to engage in learning. Lesson plans using GIS have been published online and are free for download. Esri Australia, for example, offers a number of short online lesson plans using the web-based ArcGIS Online (esriaustralia.com.au, 2019). These lesson plans target teachers at the beginner level and provide units linked to the Australian Curriculum: Geography. Training in GIS is also available online and free of cost.

The following outlines and discusses two Year 8 inquiry-based teaching activities using GIS.

Year 8 Geography teaching unit – Landscapes and Landforms

In Year 8 Geography, there are two units of study, Landscapes and Landforms and Changing Nations, targeting topics of physical and human geography, respectively. The first example presented below involves an in-depth study of mountains. GIS is introduced and embedded into practical field activities in Kosciuszko National Park. Students use their own digital devices to collect data through the ViewRanger app and Esri Collector app.

Learning objectives

The general learning objectives of this teaching unit, in combination with GIS, are:

- to produce a cross-section from elevation and location data, which can be viewed and then used to calculate distance in Google My Maps.
- to identify different vegetation types with increasing altitude, which can be viewed and analysed in ArcGIS Online;
- to understand the impact of fire on the subalpine/alpine environment of the Australian Alps.

Prior to taking students on the excursion to Kosciusko National Park, students are introduced to the concept of landscapes and landforms, their value, and processes such as weathering and erosion. Furthermore, mapping skills as part of geographic inquiry are practised. The following learning activity is designed to teach the construction of cross-sections using digital data. Students explore topographic maps and construct cross-sections manually from contour lines before applying the affordances of GIS.

Learning Activity 1 – constructing a cross-section using Google My Maps

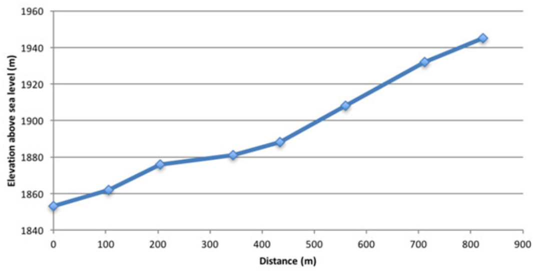
Students require access to a portable device, either a phone or a tablet, and the ViewRanger and Esri Collector applications. Depending on students' prior ICT skills, it may be beneficial to have screenshots of step-by-step guidelines on how to use these apps as well as how to view the data later in Google My Maps and ArcGIS Online.

This activity is easy to prepare and teaches students how data can be collected, imported and manipulated. Before students collect location and elevation data on the fieldtrip, they practise on the school campus. Guided instructions are useful for students to work on their own while the teacher attends to students experiencing difficulties. Before commencing the field trip students should be familiar with the calculation of geographic coordinates and elevation data. This activity can be conducted in any type of environment. Note that ViewRanger requires a data connection to operate so a remote location without phone reception is not suitable. The Esri Collector app, however, works offline. Examples of a map and the corresponding cross-section from this activity are provided in Figures 1 and 2 respectively.

Figure 1: Map (Google My Maps) with location points

Source: with courtesy, A. He, 2016

Figure 2: Corresponding cross-section



The lowest elevation and 0 point along the x-axis correlates to the location point of Charlotte Pass, going up in elevation towards the Upper Chairlift location point.

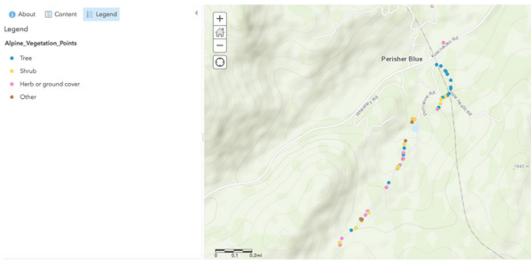
Source: with courtesy, A. He, 2017

Leaning Activity 2: Identifying and categorising different vegetation types, using Esri Collector

The second activity is based on the free web course 'Teaching with GIS: Field Data Collection Using ArcGIS' (esri.com, 2019) and can only be accessed once the teacher has an Esri account as well as installed ArcGIS Pro or ArcMap software (which is part of the free campus license). The web course takes about five hours to complete and guides the teacher to set up a vegetation field survey map that can then be shared with students. To access this map, students require an ArcGIS online account (individual student accounts need to be set up by the administrator of the school campus) and the Esri Collector app installed on their phone.

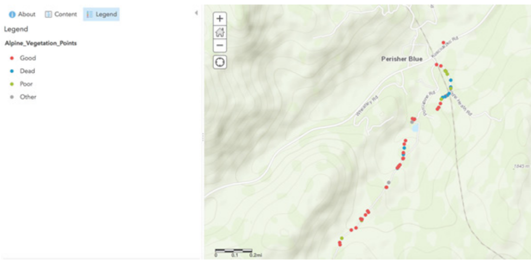
The created Collector Map on vegetation data allows students to identify different types of vegetation (tree, shrub, herb, other) and categorise their findings, for example, in regard to a tree's condition as poor, healthy, etc. These categories can be pre-defined, either by the teacher or by the class. They become available as a drop-down menu once students have logged in to the app. As with the previous activity, it is recommended that students practise collecting and viewing data prior to the excursion. Exploring the school campus is an easy way to achieve this. There are three main steps for students to complete: a) logging into their ArcGIS online account and creating a password, b) collecting data on a portable device which automatically synchs the data to ArcGIS Online, and c) accessing and viewing their data on a shared map displayed in a web browser, using the web-based ArcGIS Online. Examples of vegetation data that students collected on a walk from Perisher Ski Resort to Porcupine Rocks are provided in Figures 3 and 4.

Figure 3: GIS data inquiry – Vegetation Types



Source: Author with Year 8 Geography class, using ArcGIS Online, 2017

Figure 4: GIS data inquiry – Vegetation Condition



Source: AUTHOR with Year 8 Geography class, using ArcGIS Online, 2017

Evaluation

The difference between these two Year 8 Geography activities can be considered in terms of user-friendliness, teacher's time-investment and data analysis. The ViewRanger/Google My Maps is easy to set up, but requires more teacher-guided instructions. Esri Collector/ArcGIS Online, on the other hand, requires teacher investment time to acquire the skills necessary to create a map query and set up individual accounts (there is also an option to have one account for all students that is then shared between the whole class). When viewed only in regard to the wealth of data, using Esri Collector/ArcGIS Online will create a richer learning experience. This is especially true as ArcGIS Online has several built-in functions, for example, a buffer function, that allows the analysis of data, whilst in Google My Maps data can only be viewed. Students can analyse where certain types of vegetation are more common, grouping them and using this data for further analysis. For example, some trees along the Porcupine Rock walk had died due a fire. On ArcGIS Online, students were able to single out these 'poor' conditioned trees to identify how far the fire had reached.

The first activity teaches students valuable numeracy and ICT skills, for example multiplying the geographic decimal degrees by minus one to express southern latitudes or having to import a GIS-compatible file (e.g. '.csv'). It also provides opportunities to distinguish between different coordinate systems as different phones have different settings, thus the location data collected may vary from geographic coordinates of degrees, minutes, seconds to decimal degrees and UTM coordinates. It should be noted that the .csv files described in the first activity can also be imported into ArcGIS Online, which also allows for the measurement of distance. Google My Maps, however, has a simpler-looking interface, with less distractions for students. During a field experience, it is advisable to limit data collection to certain sections or specific points of the route. Students should have opportunities to experience the environment without the distraction of frequently looking at their device. Therefore, it is the teacher's responsibility to provide locations where GIS can be used purposefully.

These two field-based GIS activities facilitate students' spatial thinking, for example when constructing a two-dimensional cross-section from their own digital data. By allowing students to determine their own data queries students gain autonomy and a sense of ownership. This also allows them to problem-solve and work as a team.

Conclusion

In summary, GIS allows students to visualise, query and analyse data within field activities enabling them to physically interact with the environment. Constructing cross-sections is positively correlated with spatial visualisation abilities (Cohen & Hegarty, 2012). Using spatial data for analysis as presented in the second teaching activity can equally enhance students' spatial thinking skills, helping them to organise and structure data (Lee & Bednarz, 2009). Whilst the second teaching activity may be more time consuming for teachers to set up, it allows for inquiry-based learning and greater manipulation and analysis of the collected data. But training is necessary so teachers have the skills to provide such lessons. Collins and Mitchell (2019) recommend that to achieve long-term success with GIS implementation in the classroom, pre-service teacher training in Geography should improve and include adequate training in GIS, beyond the mere awareness of the technology. These writers also call for improvements in professional development in GIS for teachers. Teachers often limit the use of GIS to displaying spatial data (Walshe, 2017) instead of using the more complex functions of spatial analysis.

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