Using GPS in Forensic Science

Session: Integrating GIS and GPS

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ABSTRACT

This paper covers the introduction of GIS and handheld GPS as problem solving tools in a forensic science class. The students looked at crime mapping and considered how crimes can be location based and conversely how safety can be related to location as well.

The students used GIS and GPS data combined with photos of the school area to develop a safe route to school from a local railway station.

The introduction of GPS and GIS to forensic science was successful in allowing students to examine a problem in a different way and present a series of solutions to the class and then develop a group response. There were some initial concerns with students learning a new technology although with some training they were happy to use this software.

The use of these tools and the new teaching approach has been successfully introduced into the school and further use is likely to continue with a number of teachers.

Introduction to the use of GIS and GPS in a classroom

Stage 1: Introduction to suburb wide crime figures in Forensic Science

The forensic science class that our school offers covers a number of topics and is always fluid in its curriculum content. One of the student assignments was a PowerPoint presentation based on examining the case of a famous serial murderer and the Harold Shipman case *(*http://www.policefoundation.org/pdf/vol5issue2_color.pdf*, page 6 onwards)* introduced the class and the teachers to the concept of 'crime mapping'.

In 2003, I was seconded to the education unit of the Australian Bureau of Statistics (www.abs.gov.au) where I spent a year developing GIS based teaching material based on their Census data. When I returned to my school I realised there was little use of GIS in most schools and started to look at ways of introducing GIS as a tool of analysis and then GPS handheld units as a data collection device. As a science teacher I was especially interested in its application to science teaching.

There was some simple data available, covering a set of years, from the police website (http://www.police.vic.gov.au/retrievemedia.asp?Media_ID=23974) which gave the crime totals for each suburb across Victoria, Australia. There were initially no freely available digital maps of these postcodes so students used printed maps and developed their own scales for the number of crimes in the suburb. Although this was a very simplistic approach to the examination of crimes in localities, the students found this interesting and their first consideration was the level of crime in their own suburb. Students commented on how the data, and the maps they produced, often reinforced their prejudices about certain suburbs.

The introduction of a GIS based teaching approach occurred when the ArcExplorer program was used to display the data. The Australian Bureau of Statistics released Shape files that could be used for the suburbs. These shape files and the original suburb data were merged using a copy of ArcMap and this data was made available to student to use in ArcExplorer as the school itself did not have a copy of ArcMap.

These new maps were used by students to examine changes to the crime figure over a number of years. The students were left to design their own maps to illustrate the crime data and what it could show. Some consideration as to why crimes occurred in specific areas could be undertaken when students allocated different colours to different suburbs based on their own understanding of these suburbs. When an extra layer, public transport: train lines was added a spatial pattern linking crime rates and access to transport could be seen. The white areas where there seems to be no crime are interesting anomalies as they are the sites of Universities with large student populations but few people living there.

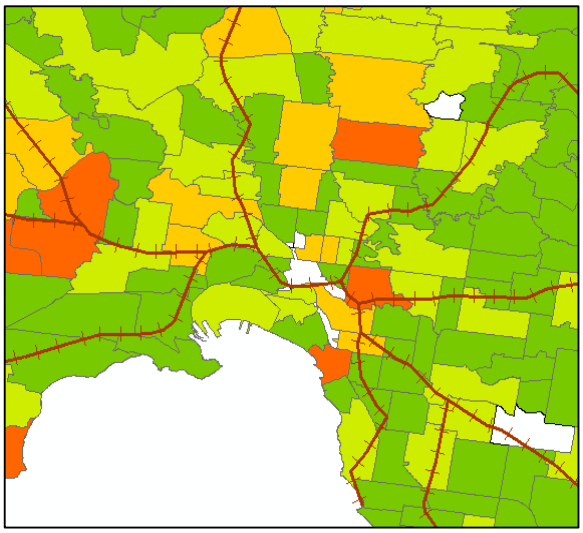


Figure 1: Crime statistics for suburbs across Melbourne, Victoria

The information provided by the analysis of suburb level lacked detail and was not all that relevant to the individual parts of suburbs although when the students discussed the work with their parents many of the parents were interested in where the ‘good’ suburbs actually were.

Stage 2: Training in the use of Handheld GPS units as a tool for science teaching

A visit from an Inspector from the Melbourne Homicide Squad was able to provide a detailed background to crimes that police investigate in the area and therefore the students became more aware of the area around the school and the types of crimes that occurred there.

A murder case (http://www.melbournecrime.bizhosting.com/christopher.hudson.htm) led to the school being ‘locked down’ (a very rare occurrence in Australian schools) while the police looked for the murderer and this provided some local excitement for the students. The murderer, who originally lived near the school and was captured within a mile of the school, provided the starting point for a discussion of safety around the school and to public transport centres.

After some discussion with the students a project was developed where the students would use handheld GPS units and georeferenced images provided by the local City GIS officer. The students had not used GPS units to collect data before. The school had 4 Garmin 12 GPS units and the students used these.

Rather than developing a detailed set of instructions on the use of these units the students were given a Rogaine course based on the school property with longitude and latitude values supplied and a question related to those points. Some locations were given and the students had to give the longitude and latitude for those spots with more points for these values. The introduction of a competitive element with chocolates for a prize provided a greater enthusiasm than for some other school activities. A part of the course details is provided below.

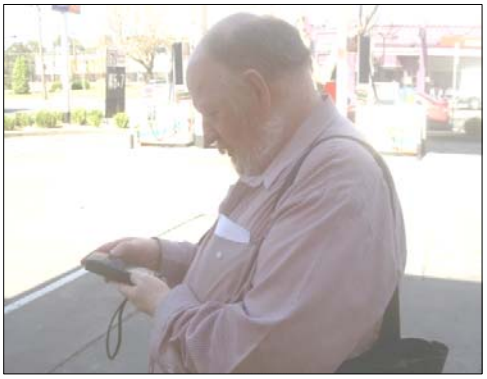
Location								Points	Question	Answers
37°	49'	29.3" S		145°	0'	48."	E	0	Basketball centre outside library!	
37°	49'	" S		145°	0'	"	E	10	Where are the oars hanging	
37°	49'	" S		145°	0'	"	E	10	Where is the Lindros memorial?	
37°	49'	28.3" S		145°	0'	47."	E	5	How many steps are there?	
37°	49'	24.9" S		145°	0'	47."	E	5	What are the two serial	

This approach worked very well and students had no problem finding and recording locations both on paper and using the mark function of the GPS unit. A finding of this initial stage looks at the level of skill students need to be able to use and understand the function of a tool in their studies. It is not necessary to teach students the complete range of a tools capability before they start using it to achieve the task set. A copy of the documentation for the GPS unit was downloaded and made available to the students for them to review at their own pace.

Stage 3: Collecting and analysing personal data

Students discussed their own issues relating to safety and how they travelled to school. The school is a Government single sex Girls school so there may be different issues relating to travel safety than in a co-ed school.

The school is located between 2 major train stations within a reasonable walking distance of the school. One station is situated up the road from the school and involves the students working about half a mile along a major road to school although the other station on a different line involves the students walking through back streets, across a park and over a major road to get to school.



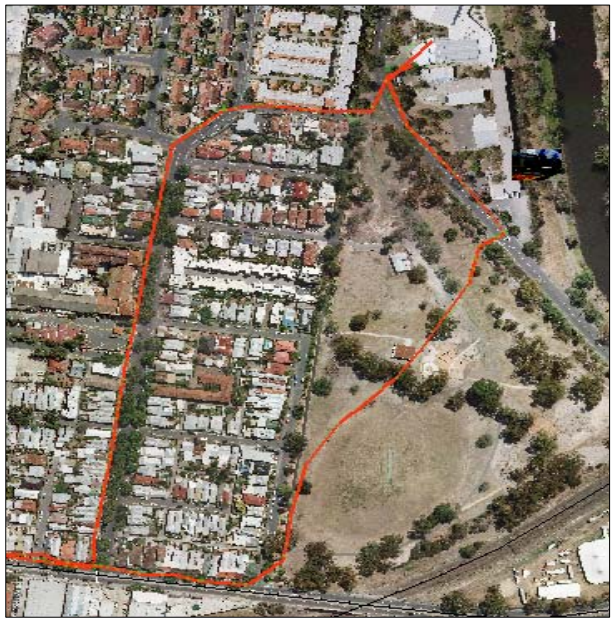
The author adjusting one of the Garmin 12 units.

Students identified general concerns involving crossing a park and travelling through the back streets although most of their concerns involved their personal safety. A few guided questions helped to raise other possibilities such as physical dangers through construction areas along the edge of the park and the changes in safety that would occur from when they travel in groups before school to concerns if they arrive late when travelling alone.

The students, accompanied by a teacher for their safety, explored the different alternative paths to the schools and recorded descriptions, took digital photos and used the handheld GPS units to record locations. They imported this data into both Google Earth and then ArcMap as the school had a free one year licensed copy of the ESRI product as part of their entry into the Australian Spatial Sciences' "Spatial Technologies in Schools" competition.

Students initially used Google Earth to display their data as it was easy to import the data and they had access to the software at home. Teachers need to look for all opportunities to allow students the opportunity to map and analyse their data.

The main findings came when they started to use ArcMap and analysed their data and considered the 'dangers' they faced on the way to and from school. The map on the right was one of the paths produced by a group before they started to analyse the path itself. Several of the groups chose narrow lanes because they were more direct even where there were alternative routes. A number of students marked far more points than they needed to rather than selecting appropriate points.



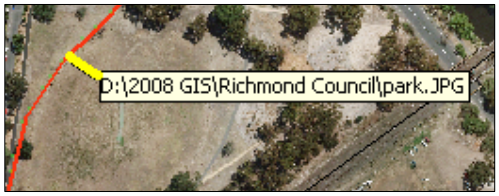
One of the student paths from the school to the railway shown in bright red to emphasise the path.

Students were able to annotate their maps and display the underlying data for each point on the path they found and later added comments and descriptions although these often lacked detail. They were also able to hyperlink photos to add extra information to the overall map.

The data points from the handheld GPS units and the photos from the digital cameras contained the date and time so that they could be aligned easily so long as the camera times were set accurately. One of the GPS units was occasionally unreliable and did not always store the marked points so some data had to be discarded.

Location: 145°0'52.127"E 37°49'30.653"S

Field	Value
FID	42
Shape	Multipoint
elevation	0
creation_t	2008-09-03T07:41:48.
magnetic_v	0
geoid_heig	0
comment	03-SEP-08 01:07
descriptio	
source	
url	



The table to the left shows some of the data for a specific point and the digital image above shows the link to a stored photo.

Stage 4: determining safe routes and eliminating dangers

Students discussed their own routes and the dangers that they found and started to build up a set of alternative paths. It initially looked like a maze of dead ends as they decided which areas to highlight or remove. Some alleyways were indicated as being dangerous and then removed from the some possible alternative routes.

The digital images provided by the local City authorities were very detailed as shown where a specific laneway was considered unsafe as there was no exit and a number of locked gates that people could open and drag a student through.

The symbols chosen were from the ArcMap crime symbols and students chose their own shadings to indicate the danger. The students tended to use simple symbols although there were a number of other possible symbols sets available.

When the students were asked if they used this laneway many did as it lead straight to a fast food outlet! Comments on the possible danger of this approach were not really considered.

There were some areas that were safe but lead to dead end streets or walled areas. These were indicated as though they were brick walls.

Some students also indicated specific areas that were 'inappropriate' at some times such as the coffee shop near the school as they knew that some of the teachers stopped there on the way to school and the students didn't wish to see the them before they needed to. This started to reduce the overall number of pathways to school.

Stage 5: The students review their findings

The students had collected all of their data on alternative paths and imported this into ArcMap and then added some hyperlinks to photos that showed specific dangers. They made some initial decisions on various paths that were not suitable or safe and certain areas that they wished to avoid.

The sets of maps were then presented by each group on an interactive smart board to the whole class and there were a series of discussions relating to why various decisions were made. After a number of revisions a final map and suggested pathway from the station to school and back. This map was then presented as an annotated map on the schools internal communications system.

The educational use of GIS and GPS

This was the first time that GPS and GIS had been used at the school as an educational tool and it was interesting to see the response of the students. The students had little trouble mastering the use of the handheld GPS units although they were set up for local conditions before being given to the students. They were quite enthusiastic about the activity and the use of the tools and when surveyed they thought this was an interesting learning experience.

The students were able to mark data points and import these into ArcMap and hyperlink them with photos that were also taken. There was some difficulty recording all of their written annotations especially as many of the comments lacked detail. In future classes more detailed sets of external data will also be collected including written commentaries so that a number of representations can be presented to the students.

As the students had not used any form of GIS before they were given very detailed sets of 'step by step' instructions on how to import data and how to use features of ArcMap. Future classes will be given more individual instruction so that they can learn the features that interest them. Another teacher is taking the class this year and will be conducting the same activity although they will need to be mentored on the use of GIS and GPS. One of the extra advantages of this project was that it provided a good example for other teachers to incorporate this and other tools into their science classes.

There is a concern as to the level of GIS implementation and analysis as much of the analysis could have been done in a number of ways. The use of GIS and interactive white boards with the ability to add and remove features allowed students to consider a number of options that they would not have otherwise been able to easily visualise. The project could be extended by using other ArcMap features although these are middle school students who are learning completely new software and thinking approaches.

Conclusion

The introduction of GPS and GIS to forensic science was successful in allowing students to examine a problem and present a series of solutions to the class and then develop a group response. There were some initial concerns with students learning a new technology although they were happy to use this software.

The use of GIS and GPS has also been extended to some junior mathematics classes to examine coordinate geometry and to environmental science classes to develop improved management approaches.

The use of these tools and the new teaching approach has been successfully introduced into the school and further use is likely to continue with a number of teachers. There is a potential for further development of the teaching approaches and mentoring for other teachers so that students will be able to use new tools in their learning.