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# Virtual Field Trips: Using Google Maps to Support Online Learning and Teaching of the History of Astronomy

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### Abstract

I report on a pilot study on the use of Google Maps to provide virtual field trips as a component of a wholly online graduate course on the history of astronomy. The Astronomical Tourist Web site (http://astronomy.swin.edu.au/sao/tourist), themed around the role that specific locations on Earth have contributed to the development of astronomical knowledge, was created using the Google Maps application programming interface. Students used this Web site as a component of their assessment and to help motivate and support online discussions. The site also aims to help build a stronger online community among geographically distributed students as they share in the creation of an Internet resource that will be used and enhanced by others over time. I describe the structure of the Web site and how it was integrated into student essays, and I provide a summary of student responses to this new learning and teaching approach. This project is an example of how Web 2.0 applications can be used to build new learning environments.

## 1. INTRODUCTION

On the night of 13 March 1781, William Herschel looked through his homemade telescope from the backyard of 19 New King Street, Bath, United Kingdom, and our view of the Universe was changed forever. Herschel's discovery of Uranus was a significant moment in astronomical history, but for most students, reading about this event in a textbook or on a Web site is as close as they will get to experiencing what happened that night. In 2007, I visited Herschel's former house, which is now operated by the Bath Preservation Trust at the Herschel Museum of Astronomy. Standing in the very backyard where Uranus was first identified made those textbook readings come to life in a way they never had before. I wanted to share this experience with my students, who were taking part in an online course on the history of astronomy. But with students distributed around the world, a physical field trip was out of the question. However, there are several online mapping projects that make virtual field trips feasible, and in many cases, the detail and quality of the imagery is almost as good as being there in person.

To this end, I have created the Astronomical Tourist: a Google Maps mash-up (defined in Section 2) themed around the role that specific locations on Earth have played in the development of astronomical knowledge. The Astronomical Tourist Web site (hereafter, ATsite) aims to encourage its users to visit these locations, either virtually or in person. By integrating the ATsite into the teaching of a wholly online course, I aim to provide an ongoing student-centered learning task: Students seek out new locations to add to the ATsite or write descriptions for previously identified locations. This project is an example of Web 2.0 community content development, with the hope that the students will be reinforcing their understanding of the history of astronomy. As part of a pilot study on the effectiveness of this approach, students used the ATsite as a component of their assessment and to help motivate and support online discussions. In this article, I report on that pilot study and the responses of the participants.

The remainder of this article is set out as follows: Section 2 introduces the concepts of digital maps and mash-ups. Section 3 provides a brief technical overview of the ATsite and how it is used. Swinburne Astronomy Online is outlined in Section 4, along with a description of the pilot study. In Section 5, I present initial student feedback on the pilot study. Section 6 presents suggestions for future enhancements and a discussion of some issues surrounding the moderation of the ATsite, particularly its potential future use as a public Web resource. Finally, in Section 7, I provide some closing remarks on this learning and teaching approach.

## 2. DIGITAL MAPS AND MASH-UPS

Mapping is an essential part of astronomy: from the tentative identification of early celestial maps dating from the Upper Paleolithic era in the Lascaux caves (c. 40,000–10,000 BC; see Rappenglück 1999) to the ceiling reliefs in Egyptian tombs; from the globe of the Farnese Atlas (c. second century AD; see Duke 2006) to the magnificent decorative star maps of the Middle Ages; and from modern three-dimensional astrometric projects such as HIPPARCOS (Perryman et al. 1997) and GAIA (Perryman et al. 2001) to maps of the space distribution of galaxies, including the 2dF Galaxy Redshift Survey (Colless et al. 2001) and the Sloan Digital Sky Survey (Adelman-McCarthy et al. 2007). A history of terrestrial and celestial maps may be found at the extremely detailed Web site of Friendly (2001).

A digital or computerized map offers the standard features of a more traditional paper-based map, but the map data are stored and/or presented in a digital format. It is this digital nature that allows an enhanced level of functionality beyond paper maps, including the ability to access them from a Web page. One of the first accounts of the advantages of computerized mapping and how such systems might work was by Tobler (1959). Today, digital maps and driving directions are among the most popular search queries on the Internet (Geller 2007). The four major free providers of Web maps are MapQuest.com, Yahoo! Maps, Microsoft Virtual Earth (or Live Search Maps) and Google Maps (see Table 1). Related to the Web mapping sites, where the maps are presented online within a browser interface, are applications like Google Earth and Microsoft Virtual Earth 3D. These provide additional functionality, such as inclusion of three-dimensional models of buildings and the ability to "tilt" the landscape for more realistic flyovers. In the present work, there was a preference for a browser-based solution, which provides greater operating system/platform independence for the end users.

Online mapping sites typically allow users to click and drag maps, zoom/change resolution, select from alternative views such as satellite imagery or street maps, perform geocoding (conversion of descriptive location addresses into latitude/longitude coordinates), overlay additional information (such as markers, images, and polylines), and integrate with databases, including real-time updates. Each of the major online mapping sites listed previously provides its own application development interface (API), which gives functional access to all the mapping features. The APIs are freely available for noncommercial and educational users, although developers must register for a license key (see Table 1). The API enables the creation of new Web applications built on top of the mapping infrastructure by providing a platform for implementing a geographic information system (GIS). Put simply, a GIS combines spatial mapping with additional geographical information, such as the presence of roads, natural resources, population counts, and so on.

**Table 1.** The four major providers of digital Web maps. URLs are given for the public user interface to each mapping project and the development interfaces for building mapping applications.

| Mapping Site | User Interface | API and Developer Kits |
|---|---|---|
| MapQuest.com | http://www.mapquest.com | http://developer.mapquest.com |
| Yahoo! Maps | http://maps.yahoo.com | http://developer.yahoo.com/maps |
| Microsoft Virtual Earth | http://maps.live.com | http://dev.live.com/virtualearth/sdk |
| Google Maps | http://maps.google.com | http://code.google.com/apis/maps |

Of particular interest to Web application developers are mash-ups: combinations of (potentially) unrelated Web applications or content sources to create a new type of application. Paul Rademacher, who developed the first recognized Google Maps mash-up, combined the classified advertisement Web site craigslist with Google Maps to show locations of available real estate. This was soon followed by Adrian Holovaty's Chicago Crime Web site, which was used to provide continuously updated crime statistics linked to localities in Chicago. In the wake of the Hurricane Katrina disaster in New Orleans in 2005, Jonathon Mendes and Greg Stoll started Hurricane Information Maps, a Google Maps mash-up that allowed survivors and their families and friends to share information about their experiences (Miller 2006). Wikimapia, created by Alexandre Koriakine and Evgeniy Savelie, combines Google Maps with a wiki system: Users are able to tag locations and provide brief descriptions. At the time of writing, there are more than 6.5 million places marked and a user community of 150,000 people contributing to the project.

Web mapping, APIs, mash-ups, and the online community involvement in contributing to and modifying content are all elements of the Web 2.0 experience (O'Reilly 2005), although debate continues as to whether this is really any different from what Web 1.0 offered (see Alexander 2006; Lanningham 2006). Researchers from a diverse range of fields are beginning to explore the potential of Web mapping applications to support their scientific goals and to engage public interest in global research projects, such as following the migration of electronically tagged walruses or live tracking of Arctic ice flows (Butler

2006). Vandenburg (2008) described an experiment at the Kingston Fronteanc Public Library in Kingston, Ontario, Canada, using Google Maps as an interface for browsing geographic subject headings in the library catalog. A growing number of educational projects use Web maps to provide interactive, community-driven alternatives to traditional classroom activities.

# 3. THE ASTRONOMICAL TOURIST

The ATsite was developed as a means to identify and visit locations on Earth relevant to the history of astronomy. Using the Google Maps API and a simple database, it is possible to mark locations and provide information on them, such as location name, description, images, Web links, and so on. Through enhanced functionality, visitors can check alignments with significant astronomical events—for example, solstice sunrise positions, lunar standstills, and other forms of horizon astronomy (see Section 6). The ATsite allows students to take virtual field trips to otherwise inaccessible locations and perform simple tasks to enhance their understanding and appreciation of astronomically significant locations. The high level of visual detail available with Google Maps reveals the layout of many modern observatories and ancient sites, and even the former homes of famous astronomers. The goal of the ATsite is for students to identify and then describe locations as they work together to build an educational resource that is continuously updated.

Google Maps was chosen for the present work because of my familiarity with it compared with alternative Web mapping sites. The Google for Educators site already provides several learning activities for supporting teaching in astronomy, particularly through the complementary Web maps Google Moon, Google Mars, and Google Sky (initially released as an extension of Google Earth but available in a browser version as of March 2008). The Astronomical Tourist serves as a complementary resource to these other Web-based mapping projects.

The two main areas of the ATsite are the Main Page and the Members Area. The majority of user interaction occurs via the Main Page: This is the public face of the ATsite. For visitors to the Main Page, the ATsite has three display/access modes: world, country, and location. With regard to the database structure (described next), the world contains countries, and each country contains one or more locations. An example view of a location (19 New King Street, Bath) is shown in Figure 1. Note the yellow star, which marks the coordinates of the site, the title, and site classification (upper right: William Herschel Museum), and the textual description of the location. The high level of detail in the Google Maps image is apparent by comparing it with a photograph taken from the backyard (looking toward the house). A country mode view of Australia is shown in Figure 2.

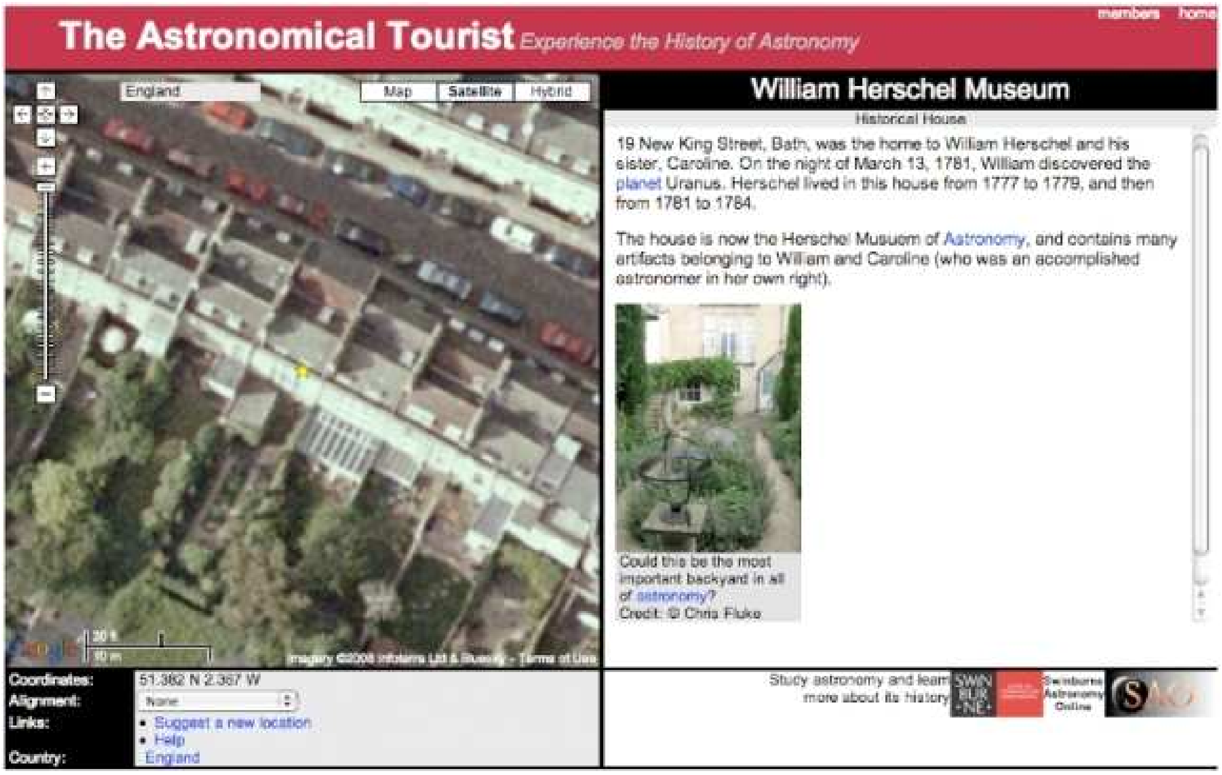


**Figure 1.** Main Page: location display mode. William Herschel's former house at 19 New King Street, Bath, United Kingdom, as seen from the ATsite. The textual description and image are obtained from a content management system (CMS): note the automatically generated hyperlinks (blue) into the COSMOS Online Encyclopedia, which is also stored in the CMS.


**Figure 2.** Main Page: country display mode. Locations currently identified for Australia.

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As a mash-up, the ATsite integrates Google Maps with a simple set of text data files that contain location details (e.g., location name, latitude, longitude) and a separate (preexisting) content management system (CMS) that is used to store descriptions and images of each location. The conceptual structure of the ATsite is shown in Figure 3.

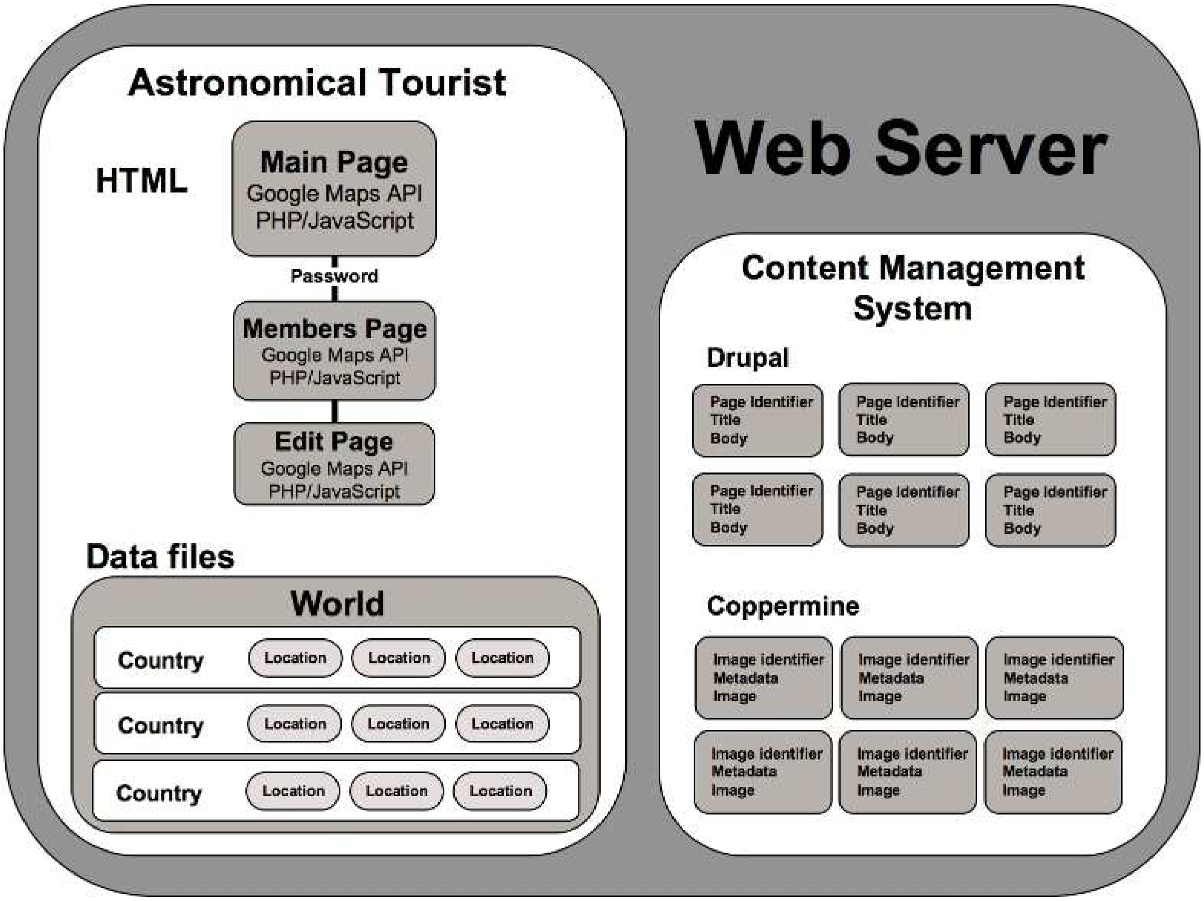


**Figure 3.** Structure of the Astronomical Tourist Web site. The Web server holds both the ATSite content (HTML and text data files for each location) and the content management system components: Drupal and Coppermine.

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The CMS combines Drupal (a widely used open source Web-based content management database) and the Coppermine Photo Gallery (a PHP application linked to a mySQL database to store and serve images and associated metadata). The primary uses of this CMS are to serve content for Swinburne Astronomy Online courses (see Section 4) and provide entries for COSMOS, the Swinburne Astronomy Online encyclopedia of astronomy. Integrating ATsite descriptions into the CMS encourages reusability in other online education activities and provides an easier framework for future additions and revisions. Further technical details on the CMS structure may be found in Barnes et al. (in press).

Currently, a separate text file is used for each location; a better long-term solution may be to put these into a SQL database. Each data file contains the location name, the latitude and longitude, the default zoom resolution (chosen to best show off the site based on the available map image quality and the physical size of the location), a type classification (see below), and a page identification number indicating the Drupal database entry that contains the location's description. Each Drupal page comprises a Title and a Body (textile-formatted text and optional image tags into the Coppermine gallery).

The ATsite Web pages use a combination of PHP (server-side) and JavaScript (client-side) code. In general, PHP is used to handle file input/output and the parsing and display of text and images from the CMS. JavaScript code provides functional access to the Google Maps API, including overlaying markers and responding to map events such as dragging, clicking, and zooming. On loading the Main Page, the following tasks are completed:

1. The Google Maps API license key is transmitted, and the required map is obtained and displayed.
2. Data files are read and the map is populated with country or location makers using the `GMarker(latlng, icon)` constructor and `map.addOverlay(marker)` methods of the API.
3. Content is requested from the CMS and custom filters are applied, such as auto-linking of key words to the COSMOS online encyclopedia.

Additional JavaScript code enables the display of pop-up text when the mouse cursor hovers over a location icon, and alignments with significant astronomical events are drawn using the `map.addOverlay(polyline)` method (if required). Readers interested in the specific implementation of JavaScript function calls are encouraged to view the page source of the ATsite Main Page, which can be achieved with most Internet browsers.

The password-protected Members Area is accessible only by registered users (each user is given a unique username and password) to manage the addition and editing of locations. PHP/JavaScript code on this Web page is used to:

- Read a text file that contains a list of locations for the current user.
- Display location markers as on the Main Page.
- Provide support for map searches based on geocoding and direct entry of coordinates (decimal degrees and DD:MM:SS formats).
- Add new locations to the map using a mouse click; an information window is then opened, prompting for a location name.
- Delete locations.

An additional Web page (the Edit Page) is available to registered users for editing individual locations. Options include modifying the location name, adding a brief description and a Web link, selecting the default zoom level, and classifying the location as being one of active observatory (radio/optical/other), active space facility, historical observatory, university, ancient site, historical house, natural feature, or unspecified "other."

## 4. SWINBURNE ASTRONOMY ONLINE

Swinburne Astronomy Online (SAO) is an online postgraduate degree program in astronomy. With a strong emphasis on enhancing students' skills in communicating science, it aims to teach the fundamental concepts of modern astronomy. A total of 16 units are available, covering subjects such as Exploring the Solar System, Tools of Modern Astronomy, and Theories of Space and Time. Depending on previous academic qualifications, SAO offers several entry points. Students may undertake a single subject or enroll in an extended program leading to the completion of a graduate certificate in science (astronomy), a graduate diploma in science (astronomy), or a master's of science in astronomy. Delivery of SAO courses commenced in March 1999 (Mazzolini 2000). Enrollments have remained near 250 students per semester since 2002, with participants from ~35 countries. Because of their geographical and hence temporal distribution, students communicate with each other and instructors via asynchronous newsgroups and e-mail. Assessment is via online computer-managed tests, essays, projects, and newsgroup contributions (Mazzolini 2002).

Initial use of the ATsite has been to support learning and teaching in the SAO unit HET607 History of Astronomy (hereafter, HOA). This unit traces "the development and impact of astronomy from ancient times to the present day, from the viewpoint of practicing astronomers." HOA is considered an introductory unit (no prerequisite units or astronomy knowledge assumed) and is usually undertaken by newcomers to SAO. HOA is taught over a 12-week semester comprising six 2-week units during which students read and discuss blocks of course content, supported by textbook and further reading. Each student is required to write an essay of 1,500–2000 words, which is due at the end of week 5 and constitutes 20% of the student’s overall grade for HOA. Essays are assessed on the degree of understanding of the topic displayed; clarity of explanations; quality and depth of Internet and literature research carried out and referencing skills; and overall presentation and originality.

A pilot trial was conducted in HOA during the first semester (March–June) 2008 with 11 enrolled students. Four essay topics were proposed, each requiring the student to make use of the ATsite to identify locations relating to his or her chosen topic. Because some technical difficulties were anticipated (e.g., the Web site was only tested on a limited number of Internet browsers, potentially restricting functionality to some users), students were given the opportunity to opt out of this component of the essay. As a result, no marks were awarded to students using the ATsite (however, this is expected to change in future trials). All students were given an individual username and password, enabling them to log in to their own account on the Members Area.

The four essay topics were:

1. **The Astronomical Tourist.** Have you ever visited a location associated with astronomy—as a tourist? For this essay, you should outline the astronomy that was undertaken at the site, explain why the location is important to the history of astronomy, and describe your experiences during your visit.
2. **180 Years Ago Today.** Choose one article that was published in MNRAS 180 years ago, describe what it is about, and provide a brief biographical introduction to the people and places involved. How has our understanding of the particular topic changed over time? Where possible, you should trace the historical development of the topic. Give a modern perspective and discuss the impact (if any) that this astronomical discovery from 180 years ago has today.
3. **Photography in Astronomy.** For more than a century, photography extended the reach of telescopes well beyond what the eye could see, until eventually superseded by electronic detectors. Who were the pioneers, what made them special, and what were some of the major breakthroughs in photographic astronomy in that time?
4. **Unsung Heroes of Astronomy.** In your opinion, who is an unsung hero of astronomy? An astronomer who has made (or is still making) important contributions but who has only rated a one-line mention in a history book? In this essay, you should present a brief biography of your unsung hero, discuss his or her work and its relevance, and explain why you believe it is important that he or she be recognized.

A summary of student essay choices and the number of new locations identified with the ATsite are shown in Table 2. Each of the students who used the ATsite identified between one and five locations. It is not known whether other students attempted to find locations but were unsuccessful, or whether they simply elected not to complete this noncompulsory part of the essay.

**Table 2.** Summary of student use of the ATsite to support essays for the HOA course in first semester 2008. The Locations column indicates the total number of unique locations identified by students who completed each essay topic.

| Essay Topic | Students | Used ATsite | Locations |
|---|---|---|---|
| The Astronomical Tourist | 1 | 1 | 3 |
| 180 Years Ago Today | 5 | 4 | 11 |
| Photography in Astronomy | 2 | 1 | 3 |
| Unsung Heroes | 3 | 0 | 0 |
| **Total** | **11** | **6** | **17** |

Locations were identified using the Members Area of the ATsite, as described in Section 2. Once students were satisfied with the details of a particular location, it was marked as ready for the instructor to review; no locations are moved to the main ATsite without the instructor's approval. This is necessary for use in an assessment item if two students happen to identify the same location.

Examples of locations found by the students were the Paramatta Observatory in New South Wales, Australia, and the home of the Royal Astronomical Society at Burlington House in an essay on the contributions of Sir Thomas Macdougal Brisbane (180 Years Ago Today); Mount Wilson Observatory, Los Angeles (The Astronomical Tourist); and the approximate location of the Freemason Tavern, Lincoln's Inn Fields, London, where the first meeting of the Astronomical Society of London was held in 1820 (180 Years Ago Today).

In addition to the essays, the ATsite was used to promote discussions in the newsgroups. This included the somewhat timely announcement during week 4 of the semester about the discovery of Hickman's crater (this previously unknown meteor crater in Western Australia was found by Arthur Hickman while he was browsing Google Earth in search of iron ore deposits; Glikson, Hickman, & Vickers 2008); the response to a student's posting about a previous visit to America's Stonehenge in Salem, New Hampshire, and the presence of astronomical alignments on-site; identification of the Beijing Ancient Observatory as part of a discussion on pretelescopic astronomy instrumentation (the fact that several of the observational instruments are visible with Google Maps gives an indication of their scale, prompting the question of why large instruments were used); and the Maragheh Observatory (Iran) and Ulugh Beg's Observatory in Samarkand (now Uzbekistan) during the course's coverage of Islamic astronomy during the Medieval period.

## 5. A SURVEY OF STUDENT RESPONSES

To assist in understanding the effectiveness and usefulness of Google Maps and the ATsite during the pilot trial, students were invited to participate in an anonymous online survey. The survey was not intended to provide a detailed understanding of how students relate to Web 2.0 technologies, such as Google Maps mash-ups. Instead, the focus was to obtain a qualitative view of whether the students involved in the pilot study could see a benefit to their understanding of the history of astronomy and to identify any immediate technical challenges faced by students or required improvements to the interface. The survey results presented here give some encouragement that the ATsite can be used in future semesters of HOA, and indeed in other SAO subjects. However, from the small number of students enrolled (11) in HOA during first semester 2008, and the smaller number who completed the survey (5—all of whom were students who used the ATsite for their essays), any conclusions drawn about the effectiveness of the ATsite must be treated with caution. The small user base did simplify management of the pilot trial.

The survey was prepared and performed under the guidelines of Swinburne University of Technology's research ethics policy. This included obtaining ethics clearance before commencing the survey. All the participating students were informed that their responses and comments might appear in research publications or presentations. Students were not able to answer the questions without first providing their informed consent, which could be withdrawn at any time. Participation was on a voluntary basis, and no additional marks were awarded in the assessment of student work. Nineteen questions were posed relating to the educational benefits and knowledge gained, any technological challenges faced, and the potential long-term benefit to students of a focus on the connection between scientific discovery and the locations involved. An additional two questions were posed to determine what browser and operating system combinations students were using (all students used Internet Explorer on a Microsoft Windows platform). Where opportunities for descriptive feedback were provided, participants were invited to make comments of a general nature.

The first set of questions (Questions 1–4) related to the students' prior knowledge/use of Google Maps. Questions and the range of answers are presented in Table 3. Students are identified as A–E to enable comparison between their answers.

**Table 3.** Questions relating to prior knowledge/use of Google Maps. Students are identified as A–E.

1. Prior to undertaking HET607 how often had you used Google Maps?

| Never | <5 times | 5–10 times | 10–20 times | >20 times |
|---|---|---|---|---|
| — | E | D | — | A, B ,C |

2. Prior to using the Astronomical Tourist website, how would you rate your knowledge of Google Maps?

| Very poor | Poor | Fair | Good | Very good | Excellent |
|---|---|---|---|---|---|
| — | — | B, D | A | C, E | — |

3. Prior to undertaking HET607 how many astronomical locations have you personally visited?

| 0 | <3 | 3–5 | 6–9 | >10 |
|---|---|---|---|---|
| — | A, D, E | — | B, C | — |

4. Prior to using the Astronomical Tourist Web site, how would you rate your knowledge of the locations of significant astronomical locations?

| Very poor | Poor | Fair | Good | Very good | Excellent |
|---|---|---|---|---|---|
| — | D | A, B, C, E | — | — | — |

There was no expectation that students would have used Google Maps previously, and the question did not ask about other digital mapping applications. These responses seem consistent with the high level of popularity of Internet mapping sites (e.g., Geller 2007). Student E, the least frequent user of Google Maps, noted that a slow dial-up connection was a significant limitation for accessing graphics-intensive Web sites (e.g., redisplay of images after each zoom or pan of the map). There may be a connection between all students rating their preknowledge of historically significant locations as *poor* to *fair* and the result that only one student elected to write an essay about personal experiences with astronomical tourism. An alternative explanation is that students found one of the other essay topics more closely aligned to their personal interests. From second semester 2008, SAO will move to offering only three essay topics to students in HOA and other subjects.

The next set of questions (Questions 5–10) related to the students' experiences using the ATsite, particularly the process of finding locations and the perceived usefulness of the ATsite to support essays. Questions and answer ranges are presented in Table 4. Student comments have been slightly edited for clarity and length (as indicated).

**Table 4. Questions relating to students' experiences using the ATsite. Students are identified as A–E.**

5. Approximately how many minutes (on average) did you spend locating each site for your essay?

| <5 | 5–10 | 10–20 | 20–30 | >30 |
|---|---|---|---|---|
| — | C | B, D, E | A | — |

6. How would you describe the ease with which you identified locations for your essay?

| Great difficulty | Some difficulty | Neither easy nor difficult | Slightly easy | Very easy |
|---|---|---|---|---|
| — | B | D, E | A, C | — |

7. How would you describe the usefulness of the Astronomical Tourist website to your understanding of the history of astronomy?

| Not at all useful | Not very useful | Neutral | Slightly useful | Very useful |
|---|---|---|---|---|
| B | E | — | A, C | D |

8. What was the most interesting thing you learnt while using the Astronomical Tourist website?

A: Many times the location of events that occur in history are just words on a page. It is interesting to attach a "real" location to it.

B: I found some old historical installations in NSW that I hadn't known about. It was interesting to put a picture to some places that I haven't been yet as well.

D: An appreciation of the distances between sites and the global nature of astronomy.

9. The thing I liked most about the Astronomical Tourist website was...

A: Visualization of the location

C: Its potential is incredible. With the ability to add photos, websites and information about the site, you find out more about the site than you can sometimes by visiting the site's own website. What is also good is having a description written by some one who has been there, as they will usually add something that the usual tourist-targeted descriptions don't.

D: It brought together places of interest and allowed me to view them as they are today without actually getting out of my chair.

10. If there was one aspect of the Astronomical Tourist website that I could change, it would be...

A: Add LOTS more pictures.

C: [Have] the ability to submit your own photos and go back and edit the description.

D: Some sort of colour coding system to differentiate between different eras and ages? The interface is fine.

E: Use of Google maps is too graphic intensive for my situation. I have access ONLY to dial-up internet. The constant loading to zoom or move around the site is outside my available time and patience. For this reason, I do not use other on-line map resources.

Without additional knowledge of the students' overall level of Internet skills, it is difficult to draw conclusions about correlations between the reported ease of use of the ATsite and the actual time spent per location. Based on my own experience, 10–20 minutes per site is consistent with the typical time that I spent when first attempting to find locations with Google Maps, particularly those that did not appear directly upon using the geocoding function.

With regard to the perceived overall usefulness of the ATsite to students' understanding of the history of astronomy, Question 7 would have benefited from a greater number of student responses. Although it is encouraging that several students saw some value in this teaching approach, an alternative conclusion is that the other five HOA students who did not use the ATsite for the essay, and the one student who used the ATsite but did not complete the survey, also saw no value (i.e., 3 out of 11 students found the ATsite to be useful as an extreme worst case).

Of particular note from Question 10 (regarding aspects of the ATsite that students would like to see changed) were requests for more pictures and improvements to the editing page to allow further checking of the site prior to submission for assessment (a programming bug was identified after students had commenced using the ATsite; this has since been fixed). The suggestion of additional color-coding of locations based on historical eras will be implemented in the near future.

The next set of questions (Questions 11–14) related to the use of Google Maps in Swinburne Astronomy Online assessment. Questions and result ranges are presented in Table 5.

**Table 5. Questions relating to the use of the ATsite in SAO assessment items. Students are identified as A–E.**

11. Would you be interested to see Google Maps integrated into future Swinburne Astronomy Online units?

| Definitely not | Probably not | Unsure | Somewhat interested | Definitely interested |
|---|---|---|---|---|
| E | — | B | A | C, D |

12. Would you be interested in seeing the Astronomical Tourist website integrated into future Swinburne Astronomy Online assessment items?

| Definitely not | Probably not | Unsure | Somewhat interested | Definitely interested |
|---|---|---|---|---|
| B, E | — | — | A, D | C |

13. What was the best thing about using Google Maps to support your essay?

A: You personalize the occurance [sic] of an event somewhat. You can say here is where it happened. Here are pictures of what it looks like.

C: History can be a bit boring if it is just a series of dates and places that are quoted. By using Google Maps in conjunction with the Astronomical Tourist website, it makes it seem more real and thereby more interesting.

D: Actually being forced to work out where things were and ground them in the real world.

E: No impact

14. What was the worst thing about using Google Maps to support your essay?

C: I had difficulty in locating one particular site, as its website gave only a street name with no number (on a rather long street!) and it took over an hour to track down where it was along the street. Google Maps was good though because I could use the satellite picture to kind of confirm where the building was.

D: The time taken to research the places and add them in. If pressed for time and doing more than one SAO unit the intrusion into the actual essay writing time is significant. Also, determining which places were relevant, and wondering if anything significant had been left out.

E: An additional chore with no added information

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Of the entire survey, Question 12 (regarding future use of the ATsite) was perhaps the most polarizing: Two students would *definitely not* want to see the ATsite integrated into future SAO assessment items, and the remaining three were either *somewhat interested* or *definitely interested*. These responses provide cautious optimism that the ATsite can be used because it will benefit a proportion of the students. At the same time, care must be taken to avoid this activity remaining a "chore with no added information" (Student E).

The next set of questions (Questions 15–18) related to students’ potential future use of the ATsite and opportunities to visit locations in person. Questions and answer ranges are presented in Table 6. Student A did not answer Questions 15–18.

**Table 6. Questions relating to potential future use of the ATsite. Students are identified as A–E.**

15. How likely are you to visit the Astronomical Tourist website again for enjoyment?

| Never again | Not likely | Unsure | Likely | Definitely |
|---|---|---|---|---|
| — | E | B | D | C |

16. As a result of using the Astronomical Tourist website, how likely are you to visit a location in person?

| Never again | Not likely | Unsure | Likely | Definitely |
|---|---|---|---|---|
| B | E | — | C, D | — |

17. After using the Astronomical Tourist website, how would you rate your knowledge of Google Maps?

| Very poor | Poor | Fair | Good | Very good | Excellent |
|---|---|---|---|---|---|
| — | — | B, D, E | — | C | — |

18. After using the Astronomical Tourist website, how would you rate your knowledge of the locations of significant astronomical locations?

| Very poor | Poor | Fair | Good | Very good | Excellent |
|---|---|---|---|---|---|
| — | — | B, D, E | C | — | — |

After using the ATsite, students reported that their knowledge of significant astronomical locations was *fair* (3 students) to *good* (1 student). Although I do not want to draw too strong a conclusion, the ATsite does not seem to be reducing students' knowledge of astronomical locations and is leading to a slight improvement. Two students reported that they are now more likely to visit an astronomical location in person, which is an encouraging outcome.

Finally (Question 19), students were invited to make any additional comments about the Astronomical Tourist or Google Maps:

- "I think it is a great start. It can easily be expanded to include pictures of people, charts, diagams, movies, etc." (Student A)
- "A fast internet connection is a must! Love the concept, and I think it would definitely be useful as a tourist resource for the astronomically minded traveller." (Student D)
- "My comments are based completely on the speed of internet connection. With dial-up at, best case, 52Kbps (and usually slower), I would rather not use the site. This does not reflect on the value if this were not my situation." (Student E).

Based on the student responses, some changes are now being made in the use of the ATsite as a component of assessment. As an increasing number of sites are identified and added to the ATsite world map, it is more useful to ask students to concentrate on writing descriptions for locations rather than completing the somewhat time-consuming task of identifying them with Google Maps. Such an approach reduces the problems faced by students using dial-up connections because the individual research component can still be performed without accessing Google Maps (although using Google Maps is still preferred to provide a more complete experience). This can include the process of revising or writing "better" descriptions for previously identified locations, which is a common element of Web 2.0 community writing. This was not practical in the pilot trial, in which only ~80 sites had been preidentified. In second semester (August–November) 2008, the emphasis of the use of the ATsite to support essays will move from finding them to describing them (even when they have not yet been located on the world map). The site-locating process will be offered as a voluntary activity for all SAO students and has already served as an ideal project for a group of three secondary school students on a weeklong work experience placement.

# 6. DISCUSSION AND FUTURE ENHANCEMENTS

The Astronomical Tourist Web site and its use of Google Maps provide a novel way for students to undertake active learning about the history of astronomy. In particular, it provides an opportunity for students enrolled in an online course to seek out and undertake virtual site visits, with the potential for these to be followed up in person. Simple tasks such as zooming or panning maps give a broader context for understanding each location: What else is nearby? What may have impacted the ongoing use of a particular site? Why are modern observatories often built in such remote locations? These are the types of questions that might be addressed in a physical site visit and that can be answered through the ATsite.

Along with the standard functions for marking locations, adding zoom controls, and so on, the Google Maps API provides a number of additional JavaScript functions that enable additional educational tasks. Of particular interest is the ability to overlay lines and polygons on a map. An example that has been implemented for the ATsite is the Alignment tool: Visitors can select from a drop-down list of significant seasonal alignments, such as solstice and equinox sunrises. The direction to the point on the horizon where these events occur is then indicated on the map, as demonstrated in Figure 4. This provides a quick but powerful test of the significance of astronomical alignments, which is particularly relevant for ancient sites such as Stonehenge, and the Thirteen Towers of Chankillo in Peru. Encouraging students to test these alignments for themselves would be a critical part of any physical site visit, so their inclusion in the ATsite enhances its use for virtual site visits. Other future additions could be simple distance or angular measuring tools, or making predictions of alignment candidates by marking out sightlines with a series of Web clicks (i.e., as a complement to overlaying known sightlines). For details of the implementation of these alignment functions using the API `GPolyline` data type and `map.addOverlay(polyline)` method, the reader is encouraged to view the source of the ATsite Web page, where the relevant

JavaScript code is visible.


**Figure 4.** Overlay showing the alignment of Stonehenge with the northern hemisphere summer sunrise and sunset (blue lines). Note that the azimuth is determined for an obliquity of 23.5 degrees, which places the sunrise over the Heel Stone, compared with the alignment along the symmetry axis that would have occurred during Stonehenge's original era of use ~4,000 years ago.

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As a Web 2.0 application, there are many opportunities to extend the Astronomical Tourist through incorporation of other community-driven elements, such as:

- Travel diaries: The more formal descriptions of locations (as provided by online students) can be augmented by blog-style personal reports.
- Contributed photos: This could be via a link to Flickr or other photo-sharing sites with appropriate image tags (although this can require payment of a registration fee to store large numbers of photos), or as an extension to the existing Coppermine image database used in the CMS. Image copyright and usability must be carefully managed here because some locations may have limitations on the wider use and dissemination of personal photographs.
- Related to these first two elements are the uses of audio podcasts (describing the experience of visiting, or providing a "walking tour" of particular locations) or short videos.
- Ranking of sites: This could be done based on the popularity of locations as tourist destinations or on their Google Maps image quality. For example, excellent digital imagery exists for Stonehenge and the Arecibo radio telescope in Puerto Rico, whereas the Very Large Array in New Mexico and the historic Birr Castle Observatory in Ireland are decidedly blurry. Public ratings, rankings, and

folksonomies are key elements of the Web 2.0 experience.

- Social networking (Facebook, MySpace) links for people planning to visit particular locations.
- Mobile computing/mobile phone applications: Visitors can check directions and information on their way to sites.

As trials of the ATsite continue in future semesters, both within HOA and other SAO courses, these and other features will be integrated to create a more complete educational experience for online students. The more users who regularly contribute to the ATsite, the greater the opportunities to identify and improve on descriptions. As noted in Section 5, during second semester 2008, the wider SAO student community will be invited to participate in the identification of additional locations for the ATsite. The next step may be to open the ATsite even more widely for general public contributions. However, as a credible educational site, this requires some level of moderation.

Currently, approval and validation by an SAO instructor is required before a new location or edited descriptions are moved onto the main page of the ATsite. This is manageable for the small user base within a single SAO unit, or the overall SAO student cohort (typically around 250 students per semester). As a public site, there is the need to manage a significantly larger user community, and the single-moderator approach is no longer feasible or practical. One option is enlisting additional moderators, to include SAO students. This may appeal to some students and could be used to add to their own learning because they would have to make critical judgments on, for example, the accuracy of new site descriptions. A wiki-style "edit/history/discuss" facility would be essential so that changes could be rolled back, or issues around the content or physical location of a site could be discussed. With its specific focus on astronomical history, many fewer sites can be located and described, compared with a project like Wikimapia, in which the intention is to describe anything and everything in the world. As a result, it may be that restricting the site location and description to SAO students will provide a sufficiently well-populated location map.

An alternative approach to implementing similar Web-based education projects that avoids the need for knowledge of PHP and JavaScript is to use the My Maps feature of Google Maps. My Maps allows anyone with a Google account to create a unique personalized map. However, with this approach, the user is restricted to using only those features provided through the My Maps interface (e.g., add a marker, add lines or shapes), and other students and the instructor must also have Google accounts to view the map. Such a solution was not ideal for the pilot study, in which there was a desire to integrate the solution with other preexisting educational materials in the CMS while also ensuring the reliability and security of content for use in the context of student assessment. With a custom solution, there is also greater latitude for including advanced functionality (described previously) via the Google Maps API or through mash-ups with other content sources.

# 7. CLOSING REMARKS

The Astronomical Tourist Web site is an example of how Web 2.0 applications (mash-ups) can be used to build new online learning environments. The use of Google Maps to support virtual field trips helps to clarify and strengthen the connection between the places and people involved. Students have the opportunity to share their own experiences of visits to significant locations, which personalizes the learning experience. By encouraging students to seek out locations (either virtually or by visiting them in person), active learning is undertaken. Students are encouraged to think more carefully about the types of places where astronomy occurs, whether at an observatory on the summit of Mauna Kea, at an ancient site like Stonehenge, or within the confines of an astronomer’s backyard in Bath.

The ATsite aims to help build a stronger online community among geographically distributed students as they share in the creation of a resource that will be used and enhanced by other students over time. The pilot trial has indicated that students are willing to try this approach, and they reported that the history of astronomy had some value to their learning. The trial has also identified a few technical improvements that are required to improve usability, along with the obvious limitations of slow Internet connections for such a graphics-intensive site. By placing an emphasis on describing locations rather than the initial identification process, these issues can be partly overcome so that the ATsite can be more easily integrated into future assessment items and online discussions. Once a critical number of locations (> 200) are identified and fully described, the ATsite can become a valuable online resource for the wider public to explore and learn more about the history of astronomy.

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**Web Links**

Astronomical Tourist (ATsite): http://astronomy.swin.edu.au/sao/tourist

Chicago Crime: http://chicagocrime.org

Coppermine Photo Gallery: http://coppermine-gallery.net

Cosmos—The Swinburne Astronomy Online Encyclopedia of Astronomy: http://astronomy.swin.edu.au/cosmos

Craigslist: http://www.craigslist.org/about

Drupal: http://www.drupal.org

Google Earth: http://earth.google.com

Google for Educators: http://www.google.com/educators

Google Maps: http://maps.google.com/

Google Maps API: http://code.google.com/apis/maps

Google Mars: http://www.google.com/mars

Google Moon: http://www.google.com/moon

Google Sky: http://www.google.com/sky

MapQuest: http://www.mapquest.com

Microsoft Virtual Earth: http://maps.live.com

PHP: http://www.php.net

Swinburne Astronomy Online (SAO): http://astronomy.swin.edu.au/sao

Textile: http://www.textism.com/tools/textile

Wikimapia: http://wikimapia.org

Yahoo! Maps: http://maps.yahoo.com

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