

School-based extracurricular Astronomy

By Jeffrey J. Stanger

The International Year of Astronomy in 2009 focused considerable public attention on Astronomy and generated valuable resources for educators. These activities are an effective vehicle for promoting Science to students and to the wider school community. The most engaging practical astronomy activities are best delivered with sustained support from the astronomical community, and this community needs to know how to support them. This paper outlines a model for a high school astronomy club, presents a number of successful activities, and suggests how these activities can best be supported.

INTRODUCTION

Astronomy is arguably the science most universally embraced by the general public. This is evident through the sustained high profile that it enjoys in the mainstream media. This level of general interest can be channelled to foster enthusiasm about Astronomy through extracurricular activities for students.

As with any school-based extracurricular activities there are many hurdles to be overcome. Teachers and school resources are fully occupied delivering the lessons required by the curriculum, and there may be little time or funding available to develop these activities. It is for these reasons that this paper is focussed on assisting teachers to find resources and assistance, and to inform members of the astronomical community on how best to assist teachers.

THE ASTRONOMICAL COMMUNITY

Astronomy is the oldest of the sciences and one of the most dynamic. It is no wonder that the body of knowledge on the subject is vast, and that teachers often feel intimidated by the subject. The astronomical community therefore needs to provide teachers with assistance in the teaching of Astronomy. This assistance can vary from physical resources to educational research, or even face-to-face contact. All these will enable more students to be exposed to, and enthused about, Science.

The astronomical community includes professional astronomers, amateur astronomers, and astronomy educators. The members of this community already do an enormous amount to educate the public through publications, lectures, observatory and planetarium tours, observing nights, and many other activities. The value of their assistance to teachers is highlighted by the success of programs such as Project ASTRO, run by the Astronomical Society of the Pacific (ASP). In 2008, their website indicated that this project had facilitated professional and amateur astronomers to provide educational experiences to over 200,000 students across the United States since 1994. This involvement of the astronomical community in school children's education has undoubtedly brought an increased diversity and quality of experience to many students.

In my experience of running a school-based astronomy club since 2004 it has become clear that the involvement of amateur and/or professional astronomers has been extremely important, if not essential, for its effectiveness and longevity. Many schools do not have the equipment or funds required to run viewing nights, and many teachers do not have time to gain sufficient subject knowledge to cover some topics in depth and answer the questions from students that follow, so it is helpful to involve people from right across the astronomical community.

Professional Astronomers

Despite the demands of professional astronomy, many astronomers also devote a significant amount of time to outreach. I would encourage any teacher who is close enough to a university or professional observatory to contact these institutions for assistance. If this is not possible there are also many text, audio and video resources freely available on the Internet in which astronomers offer information suitable for students (see online appendix – links at the end of this article).

In my experience, there has always been someone more than willing to help. Visits from professionals are extremely valuable as they add a level of relevance to astronomical topics, promote careers in science, and allow students to interact with the outside world. They could take the form of a presentation of the astronomer's work, a practical activity, a video conference, or a more focused discussion and question time on a particular topic.

A more formal arrangement is for astronomers to assist teachers is the Scientists in Schools program, run by the Australian Federal Government. Any scientist can express their interest in being involved and teachers can apply to be assigned a scientist via the website www.scientistsinschools.edu.au. Astronomers wishing to assist teachers will find helpful resources through links provided in the online appendix. A paper written by Mayo (2002) was used to inform U.S. space scientists on how to run or support an after-school astronomy club.

The involvement of astronomers within schools is not only beneficial to the students involved but the exposure to astronomers is also an excellent



Photo 1: Former SGHS student and ATNF Astronomer Dr Ilana Feain talks about her career and research.

professional development opportunity for science teachers. Contact with professionals is a great chance to broaden your astronomical knowledge, and will no doubt enhance your teaching of mandatory astronomy syllabus content. Face-to-face contact with students promotes Science as a career choice, and for university-based astronomers it can also be a great opportunity to showcase their institution to prospective students.

Amateur Astronomers

A recent survey by Storksdieck et al (2002) of over 1,100 amateur astronomers in the United States indicated that two-thirds of this group were actively involved in public outreach and education. More than two-thirds of these respondents said that this involved outreach with school groups (Berendsen et al 2007). This suggests that there will be significant numbers of amateur astronomers throughout Australia who would be willing to assist schoolteachers. Despite this level of support, two-thirds of amateurs who indicated that they were involved in educational outreach also stated that they needed more activities, resources and materials to assist their outreach activities. Suggested resources listed in the online appendix may aid in addressing this problem.

The main outreach activity of the amateur astronomer is the provision of telescope viewing (Storksdieck et al 2002). This is a vital role that amateurs can play in supporting a school astronomy club, but I would suggest that amateurs have much more to offer. Berendsen (2005) clearly showed that, on average, many amateur astronomers have a level of astronomical knowledge comparable with that of university graduates in Astronomy, Astrophysics and Physics. Therefore, it is clear that amateurs can easily provide teachers with very useful information, advice and support.

In every school's local community, it is likely that there is someone who has more than a passing interest in Astronomy. This person could be a parent, a member of a local astronomy club, or simply an interested local. These people can not only provide their expertise and equipment, but also present a great example of life-long learning, and an excellent model for the relevance of Science and enjoyment of it in everyday

life. From my own experience, I know that many amateurs gain immense satisfaction from showing the Universe to others so I would encourage teachers to contact them for assistance.

Astronomy Educators

If you live in the vicinity of a public observatory or science museum, these institutions may be able to assist you by running an outreach program visit to your school. They may also serve as an opportunity for an excursion, and offer a range of activities. Many observatories or museums are also the site for meetings of public astronomy clubs or public lectures on Astronomy, at which teachers can network with amateur astronomers.

THE SGHS ASTRONOMY CLUB MODEL

The Sydney Girls' High School (SGHS) Astronomy Club was established in 2004. As I am an amateur astronomer with formal training in Astronomy, and I work at a public observatory, I have been able to provide a wide range of activities. As teachers we can all provide experiences to support student learning and this paper will provide a range of activities that could be undertaken.

SGHS is an academically-selective government girls' high school that attracts students from across Sydney. The level of astronomical interest has been amazing and I am confident that similar interest would exist amongst students at any school. This was evident in my experience at a non-metropolitan comprehensive government co-educational high school that also had an astronomy club. The common factor was a teacher on staff who was willing to facilitate those interested in exploring Astronomy.

The SGHS Astronomy Club has maintained a membership of between 75 and 150 students since its inception. Club activities are open to all students, and membership is free and non compulsory. The club is organised and run by an elected student executive of about 10 to 15 students. An incentive for participation is the chance to gain points in the school's student recognition scheme. This requires attendance at more than 50 per cent of meetings and operates for all members and the elected executive.

Meetings are held weekly at lunch time, and generally alternate between executive and general meetings. The competition for students' time means that attendance at meetings varies. The club is run at lunch times because students are involved in many other activities outside school hours. This has led to meetings and activities involving groups of between 15 and 150 students at a time, depending on the activity.

The best attended activities have been lectures. Topics covered in lectures frequently overlap well with the Science and Physics syllabuses in NSW. This has helped increase the numbers attending meetings and complements classroom teaching. For an overview of the club's activities please visit our website (link in the online appendix – see the end of this article).

STUDENTS' ASTRONOMICAL INTERESTS

Every child I have ever asked has had a question about Astronomy. It is evident that the universe captures everyone's imagination in one way or another, but it is also clear that people's interests are diverse. This diversity led me to survey my audience each year before deciding on the club's activities. From the club's

inception, I wanted my students to feel a sense of ownership, so it is run by students for students. Activities are decided by a poll each year for the following year's activities. The top three requested activities over the last five years are listed in order below:

1. Observatory excursion or telescope viewing;
2. Practical team challenges and group activities; and
3. Lectures or workshops on selected topics.

Lunchtime lectures actually attract the highest number of students. It is likely that this is because these activities do not require ongoing attendance, are free, and are conveniently scheduled in the lunch hour.

While implementing activities for the club I have learned many lessons about students' interests. The general trend is that the most popular activities are those that are entertaining and hands-on. The least-attended meetings were those focusing on analysing real astronomical data. However, students who did attend these meetings were enthusiastic and engaged. Bearing in mind student preferences and feedback, I have tried to maintain a mix of activities ranging from entertainment to authentic scientific enquiry. This has resulted in fluctuating attendance but I believe it has served a broad range of students well.

ACTIVITIES

Brief descriptions of some of the activities undertaken by the club are listed below:

Team-based Engineering-style Competitive Activities

There have been two major activities in which student teams compete to design, build and test a vehicle. One activity is building a PET bottle rocket, and the other is a Martian Lander (egg drop). Students enjoyed

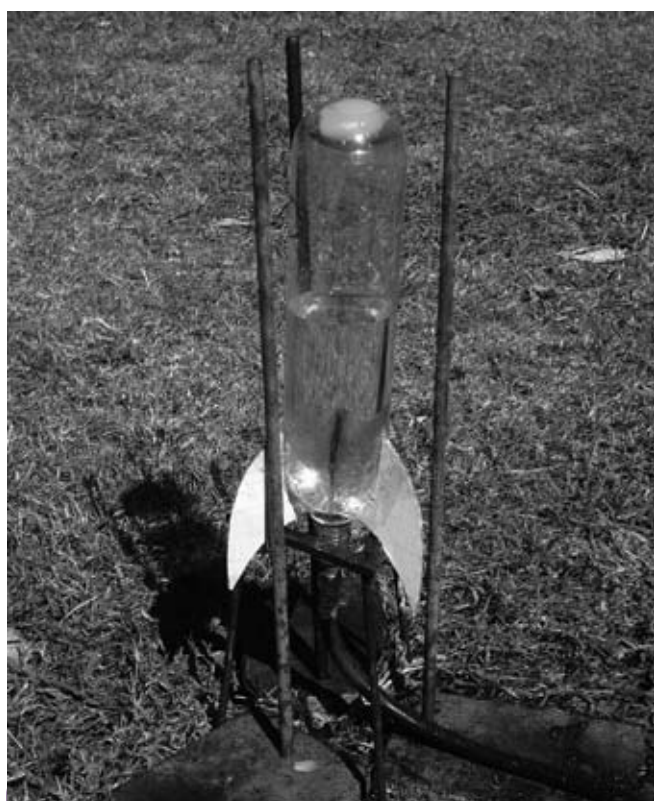


Photo 2: PET bottle rocket ready for lift-off on its laboratory equipment launch pad.

these activities immensely and many have participated several times over the years. Instructions for these activities are also available from links provided in the online appendix.

Lectures

Each year students have been offered a number of lectures by me or by visiting astronomers. Topics have included a career in astronomy, special relativity, astronomical images, astrophotography, observing the night sky, using a planisphere, black holes, moon rocks, radio astronomy, rocks from outer space, being an astronaut, ways we could die from outer space, and the life cycle of stars.



Photo 3: Students inspect samples of the moon brought back to earth by Apollo astronauts.

Discussion Forums and Question and Answer Sessions

I have run several discussion sessions on topics such as cosmology, where the main idea of the topic is introduced, and students then ask questions or discuss their knowledge. Other sessions have focused on students asking questions on Astronomy in general, or trying to stump me to win prizes. A variation on these activities was one in which where students searched the Internet for a number of astronomical images that they would like to have explained. In a subsequent meeting each image was explained and I then answered questions.

Student Presentations

Students who have undertaken work experience in Astronomy have given brief presentations to the club. These have included the research they have performed and their findings. Other students have given talks on topics of their choice. One example was a lecture on calculating the diameter of the earth using a stopwatch and the rising sun. Student presentations offer a level of relevance to their peers that a teacher may not be able to match, and are great experiences for the presenters and the audience. These activities are very popular amongst students so it can be wise to guide students with their presentation beforehand to ensure a good standard.

Multimedia Presentations

Several meetings have been a combination of explanation, videos, vodcasts, podcasts or PowerPoint presentations. One example introduced members to

the Hubble Deep Field image. This included a vodcast video. Students have also expressed an interest in producing astronomy-related podcasts themselves, and there are certainly many examples from around the world available for download. Making podcasts involves a reasonable amount of technology, but is certainly not beyond the average high school or student.

Observing Sessions (Day and Night)

Observing sessions have also proved to be very popular. The day sessions involving solar viewing have been the most popular due to running them in the lunch hour. Night-time viewing after school has either been done as a stand-alone event or as a shorter session on a night when students are at school for another event.



Photo 4: Students observe the sun in visible light and hydrogen alpha, courtesy of Sydney Observatory.

Stand-alone nights usually start with a short session on observing techniques, using binoculars, making and using a planisphere and an introduction to some of the objects we will see with a PowerPoint presentation. After a break, students then watch an astronomy video and enjoy a pizza as they wait for twilight. Once twilight starts, we set up and begin observing. Times of the year when there is no daylight saving time are best for these nights as students do not need to stay up as late or wait as long for nightfall. An excellent source of information on running an observing night can be found on the ATNF outreach website (listed in the resource section of the online appendix).

Workshops

I have run many workshops for students, teaching them astrophotography, image processing, or making a planisphere. Students enjoy these practical activities and can often apply their new skills at home. Similar workshops were conducted when students worked with images from the Faulkes telescope in Hawaii. Students were introduced to the processes used by astronomers to analyse images. They would then analyse images of star clusters and nebulae to determine their age. These activities are available from links listed in the online appendix.

Hands-on Activities

A series of practical activities were undertaken in 2007 as one of the trial schools for NASA's Beyond Einstein Explorers program (now called Afterschool Universe). Many of these were successfully completed without financial outlay. These activities are set in the context of the future challenges Astronomy faces in exploring



Photo 5: Students analyse images of star clusters taken using a remote robotic telescope.

phenomena beyond Einstein's Theory of General Relativity. Despite how complex this sounds, they are suitable for all high-school students.

Another set of activities was undertaken in 2009 as part of the International Year of Astronomy. These were selected from the IYA Discovery Guides and are discussed in more detail in the next section.

RESOURCES

A list of many resources that will assist with a variety of extracurricular astronomy activities is included in the online appendix. The rapidly changing nature of the Internet and of the body of astronomical knowledge means that, in order to properly assist teachers, this list needs to be dynamic and, when possible, it will be kept up-to-date and expanded over time.

Some resources worthy of specific mention are the IYA Discovery Guides developed for amateur astronomers for 2009, the International Year of Astronomy. These resources include over one gigabyte of files available online. Many activities are accompanied by video training, PowerPoint presentation files and detailed instructions. These resources are useful both within and outside the curriculum for students of Astronomy. A website listing these resources and providing some adaptation for the southern hemisphere is included in the online appendix. This site presents a list of hyperlinks for these activities in their sequence for the International Year of Astronomy.

ASSISTING VISITORS TO SCHOOLS

It is likely that the experience for students will be much more effective if the teacher discusses any proposed activity with its external presenter beforehand.

Modern educational philosophy recognises that students' prior conceptions are very important. It is therefore desirable for any presenter to be aware of an audience's understanding on a topic prior to any interaction. This helps the presenter identify where to begin and what to focus on. Science education today is much more than simply the presentation of facts. It involves self-discovery that is often evidence-based and relates the concept under discussion to a student's personal experience. It is active, and engaging, involving skills such as critical thinking and evaluation. Students make comparisons, ask questions and participate in a large number of hands-on activities. It is good to keep the abovementioned ideas in mind when planning an activity, as it will contribute to a more effective experience.

For presenters working with school students, it is also important to acknowledge that modern society has conditioned the average student to expect entertainment. Educators compete with media such as television and online games and have to cater for an attention span that has been altered by exposure to these media. One way to address this is to make presentations visually stimulating and, if practicable, able to break sessions into segments of say 10 or 15 minutes.

Another major consideration is students' inclination to socialise. Presenters will most likely be dealing with students who have a particularly keen interest in Astronomy, and will probably be well behaved and attentive, but this is not always the case. Allowance can be made for the social tendencies of students by including activities that require group work, such as a short discussion on what they think about a certain topic.

Students also highly value relevance in what they are learning. If you can convey why the topic you are discussing is important, students will usually be more receptive. It may be that you can convey relevance through a personal story and how it relates to the subject, or link the topic to what they have already learnt in school or will learn in the near future.

Another consideration is the technology involved in many modern presentations. Availability of technology varies widely from school to school, so this is something to check before a visit. If you or another presenter needs to access the Internet for a presentation you will need to check that this will work, as in many schools there are multiple layers of security to negotiate. All these issues can be addressed with a little prior planning and discussion.

Some final considerations I would recommend include managing your expectations of how much material you can cover in a single session. It is easy to expect to complete more activities than you actually will in the time allocated. Generally, I plan to go a little under the allowed time and leave room for questions.

CONCLUSION

Astronomy is a stimulating context within which to explore Science. Outside the confines of the mandatory curriculum, there is much scope to provide students with a glimpse into a rich and exciting world.

Professional and amateur astronomers alike have much to offer teachers and students, and vice-versa. I would encourage teachers to bring astronomers into their schools to enrich the experiences of their students. I would also encourage astronomers to support teachers in any way they can and share the subject they love with students across Australia. Setting up a school astronomy club may not be for everyone, but I hope that I have provided the insight to encourage those who can to give it a try.

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APPENDIX

Available online at

<http://www.jeffstanger.net/Science%20Teaching/School-Based%20Extracurricular%20Astronomy%20Appendix.html> and

<http://www.jeffstanger.net/Science%20Teaching/School-Based%20Extracurricular%20Astronomy%20Appendix.pdf> **TS**

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