

The Joy of GEM

Helmer Aslaksen
Department of Mathematics

General Education Modules

Teaching General Education Modules (GEM) allows me to put everything I've always wanted to do in teaching into practice! I have designed two modules GEK1506, "Heavenly Mathematics: Cultural Astronomy" and GEK1518, "Mathematics in Art and Architecture" where I aim to:

- change the way students look at the world around them,
- give students knowledge that they will enjoy for the rest of their lives, and
- make students appreciate the beauty and relevance of mathematics.

Teaching Goals

Appreciate mathematics. I love mathematics for its internal beauty and its relevance to the world around us. Unfortunately, many of our students have been deeply traumatised by the way mathematics is taught in schools. In my teaching I show the students that mathematics is not just about exams and formulas, but that it is related to a wide range of everyday phenomena.

Lifelong learning. The main reason why I wanted to become a professor is because I love learning! One of my main goals is to help students appreciate knowledge and develop a lifelong passion for learning. I also help my students understand that going to a university is not simply about getting a degree, but about picking up intellectual life skills that will serve them well, no matter what they do later in life.

Presentation. It is a sad fact of life that most of the time, it doesn't matter what you know or what you do, but how you present it. In my courses, I try to teach students the importance of clear presentations. I also stress that writing a paper does not mean simply copying dubious information from the web, but explaining and presenting the information clearly. When marking the students' projects, one of my most common comments is: "I don't understand this. Do you?"

History, culture and society. Scientists don't live in a vacuum. It is important to understand the relationship and interplay between science and society. I want my students to appreciate how people throughout the world and throughout the ages have struggled with the same problems. It is fascinating to see how they sometimes come up with fundamentally different, but equally valid solutions!

Singapore context. For both courses, I try to take a Singaporean point of view. Many astronomy textbooks (including primary school science textbooks used in Singapore) take a 'high-latitude centric point of view'. I try very hard to be 'hemispherically correct' and I sometimes describe the first part of my astronomy course as astronomy for 'latitudinally-challenged people'.

Singapore is not just a multiracial and multicultural society, but also a multicalendrical society! A major part of my astronomy course is a detailed study of the four calendars—Chinese, Muslim, Indian and Western—that determine the public holidays in Singapore. At the beginning of the course, I often get strange looks from Chinese students when I ask them questions related to Muslim holidays. They seem to think that I'm a stupid foreigner who can't tell the difference between a Chinese and a Malay. But by the end of the semester, most students seem to appreciate the links between science and society.

Critical thinking. The bookstores are filled with books about astrology, 'sacred geometry' and 'lost civilisations'. I aim to give my students the knowledge and thinking skills to enable them to separate fact from fiction.

Respect for Teaching

I love teaching. I am passionate about knowledge and I love sharing it. That's why public lectures and outreach activities are an integral part of my work.

Public lectures and outreach. I give a lot of public lectures on topics in mathematics, astronomy and art at museums, libraries, science centres and schools. I have also been academic advisor for the exhibition, *Art Figures: Mathematics in Art* at the Singapore Art Museum and *The Dating Game—Calendars and Time in Asia* at the Asian Civilisations Museum and for the TV series *Ancient Chinese Inventions* on the Discovery Channel.

When I give a public lecture at the Asian Civilisations Museum or Singapore Art Museum, I have no guaranteed audience. I have to come up with an interesting topic and abstract and make sure that working professionals would want to take time off their busy schedules to attend my talk. This teaches me not to take my audience for granted. Similarly, when I'm planning for a TV shoot with Discovery Channel, I need to keep my target audience in mind.

Public lectures tie in with my teaching and help me plan for my GEMs. They allow me to 'road-test' my courses. When I introduced my courses at the university, I knew they would be a success!

Adding value. When I lecture I always ask myself: "Am I adding value?" If I give the students detailed lecture notes, why should they bother coming to class? Therefore, I always approach each lecture by asking myself: "What do I want the students to get out of my lecture that they cannot get from books or lecture notes?"

Teach responsibility. When I teach a class with 300 students, it's easy to be overwhelmed with practical problems like insecure students asking about things that are already explained clearly on the course page. I try hard to make the students understand the reason for the rules and give them confidence to apply common sense. This is a very radical break from what they are used to in the Junior Colleges.

Visualization

I believe that there are four levels of knowledge—knowing, understanding, explaining and explaining simply!

Demonstrations. I always try to come up with analogies to explain the concepts. For geometrical concepts, I create physical demonstrations involving my own body, teaching

props or the students. In my astronomy course I assign the students to be the different heavenly bodies. Students often comment that the demonstrations help them remember the concepts better. In fact, the more hilarious the demonstration, the better they remember it! I also have a vast collection of celestial globes, sundials, navigational instruments and soft toys that I use to demonstrate the concepts.

Animations. IT allows us to go one step further by adding animations and interactive applets. With the help of the Faculty of Science's Centre for Information Technology and Applications (CITA), I have created Java applets that are essential to my astronomy course.

Website. I have an extensive website. My web page on the Chinese calendar (<http://www.math.nus.edu.sg/aslaksen/calendar/chinese.html>) is the highest ranked page about the Chinese calendar on Google! Around the time of Chinese New Year, I get up to 50,000 hits each month. The information and the links on the website allow the students to reinforce the concepts learned in the lectures and to explore further.

Alternative Assessment

I don't want to stifle creativity, but to give my students the opportunity to express themselves freely.

Project work. For both my GEMs, 40% of the final grade is based on a group project. I have a list of possible topics, but I also encourage the students to propose their own topics. They can write a report, create a web page, make a computer animation or build a physical model. It is wonderful to see how enthusiastic and creative they can be when they are given the opportunity to do something that excites them.

Innovative homework. For both my GEMs I assign two innovative homework that require students to make observations of the Sun and Moon at different parts of the year, make models of the five Platonic and 13 Archimedean solids and take pictures of five mathematically interesting things in the real world.

Conclusion

I'm grateful to the NUS for having given me the opportunity to design the kind of courses that I've been dreaming about my whole life, and to my students for having being enthusiastic in their response to my courses! I look forward to improving my courses further and to continue making a contribution to education at the NUS.