Repeating Patterns from Your Own Culture: The Value of Such an Assignment in a Foundation Class in Mathematical Art and Design

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Abstract

This article describes the success of an introductory assignment in a new course in mathematical art and design. This course, Foundation Maths and Design, first taught in 2018, is part of the Certificate in Science and Technology (CertScT) at Auckland University of Technology. The CertScT provides a pathway for students aiming for University Entrance into Art and Design. In this course, students learn to produce their own mathematical art by coding. The first assignment, which does not involve coding, is a presentation to the class on repeating patterns from the student's own culture. This was successful in bringing together a class of about twenty students with very varied cultural backgrounds. Insights are shared.

Backgound

In 2017 I was asked to write a new mathematics, art and design course for AUT Foundation Art and Design students, exploring the relationship between mathematics, art and design through the production of a creative work. Our foundation students do not have University Entrance, usually due to low English and mathematics performance at school. This course, Foundation Maths and Design, is part of the Certificate in Science and Technology (CertScT) at Auckland University of Technology. The CertScT provides a pathway for students aiming for University Entrance into Art and Design. In this course, students learn to produce their own mathematical art by coding in *Processing* [1]. This course provides me with many challenges. In this article I describe how I cope with the first challenge, which is to bring a class of about twenty students together. These students have very varied cultural backgrounds. Most of my students did not particularly like mathematics at the start of the semester and many did not see its relevance to art and design. My paper is compulsory. How should I begin?

Prerequisites and Learning Outcomes

My students are second semester students who have taken a foundation mathematics paper in the first semester. This includes basic algebra; linear, quadratic and exponential functions and patterns; and trigonometry. Foundation papers in academic literacy, problem solving and design technology are also taken in the first semester. Learning outcomes for the paper include building confidence and ability in the application of mathematical techniques, developing a design project based on appropriate mathematical principles, and documenting and reflecting on the mathematics used.

How to Begin?

I begin by showing pictures, some from nature such as flowers, leaves and shells, and examples of paintings, drawings, textiles and architecture. These pictures often have cultural significance, for example, the koru (unfurling fern frond) for the Māori, Greek meanders, Islamic geometric designs or decorative knots for those

of Celtic origin. My pictures span many cultures and many centuries. Suddenly, students are seeing patterns and symmetry everywhere and start to offer their own examples in class. I suggest a trip around the backyard at home or the nearest park to find examples of symmetry. Another teacher reported seeing my students photographing plants and sculptures all around the campus after this lecture.

Patterns and symmetry are discussed, in an introductory manner. We have a brainstorming discussion based on what symmetry might mean. Geometric transformations such as translations, rotations and scaling make their way into this conversation.

Repeating Patterns

This leads naturally to the first assignment of the course, a presentation to the class on repeating patterns from the student's own culture. These presentations usually take about ten minutes. Many students are very enthusiastic about the subject but some are daunted by the idea of speaking to the class. One challenge is to persuade every student to present.

Many of my students are the first members of their families to go to university. They are generally shy with respect to presenting material in class. I tell my students that I am concerned with the effort they have put into their research, rather than their presentation skills or level of spoken English. We schedule a few presentations per class, over the space of a couple of weeks. I let the students choose the order, allowing the shyest to go last. I found that even the shyest student presented well after experiencing the friendly atmosphere in which we all learnt from each other, lecturer included.

Patterns are presented, some history given and significance explained. Many fascinating stories and legends are told. I taught one student who spoke for more than half an hour with great fervour on Slavic patterns and their significance. She linked centuries of history and family customs to her patterns. Among many things, she spoke of the swastika and its ancient peaceful connotations. This presentation was excellent and fascinating. Our class absorbed a lot of history that day.

(a)   (b)
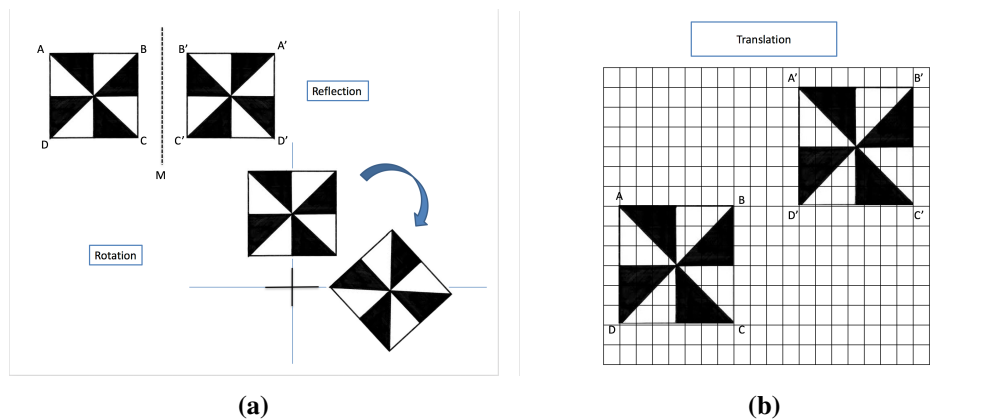
Figure 1: *From a student's assignment: (a) rotation and reflection, and (b) translation.*

A Trip Around the World

The wealth of information introduced to the class as a result of this one assignment was quite staggering. The mathematical patterns presented were analysed from a geometric perspective and linked to history, stories, myths and legends, architecture, fabric, costumes, everyday activities, family customs and religious beliefs. These patterns took us on a tour of many different countries. A total of 38 students identified with 21 different cultures or countries over two years. See Table 1.

Table 1: *Cultures and countries represented in class, as identified by the students, the corresponding
numbers of students in 2018 and 2019 and examples of topics covered.*

Culture	2018	2019	Examples of topics
Chinese	4	3	Traditional patterns including textile design, architectural symmetries, ceiling decoration, grilles, hand mirrors and murals, Yunlei patterns, Fang Sheng patterns
South Korean	1	1	The dragon pattern, window patterns, dancheong colours and patterns
Persian	1		Traditional patterns in architecture, paintings and fabrics, the Golestan Palace in Tehran, the Nasir al Mulk Masjid in Shiraz, and Isfahan
Cambodian	2		Lotus patterns and the Dong Son drum, silks, Khmer Royal Palace
Fijian Indian	1		Tapa masi, a fabric made from the inner bark of the masi (mulberry) tree, Rongoli designs
Samoan	2	2	Tattoos and tapa cloth (siapo) designs
Tongan	2	1	The manulua design
Cook Islander	1		Tattoos
Maori	1	2	Maori patterns based on the New Zealand koru, fish scales and whale teeth
Australian Aborigine	1		Significance of patterns on a didgeridoo
Vietnamese	1	1	Traditional fabric designs
Filipino	1	1	Geometry in indigenous Filipino culture, Kalinga textiles
Slavic	1		Slavic symbols and their meanings
Hong Kong		1	The swastika symbol in Slavic, Chinese and Indian cultures
Punjabi		1	Traditional patterns from Punjab
Polynesian		1	Patterns based on shark teeth, ocean waves, turtles and the Enata symbol
Croatian		1	Interlace/wattle designs
Irish		1	Celtic knots
Cherokee		1	Colour symbolism in the shamanistic system
Islamic		1	Geometric patterns from architecture and fabric
Scandinavian		1	Architecture for snowy climates

(a)

(b)

(c)

Figure 2: *(a) Manulua symbol coded in Processing, (b) the unveiling of the New Zealand Police Pasifika
police cars in South Auckland, March 2019, note the inclusion of the manulua design,
photograph credit: NZ Police, (c) one frame of a colour animation by a student.*

An Example from Tonga

One student from Tonga made a study of the traditional manulua design. This is one of the oldest designs found on traditional Tongan bark cloth. The triangles represent two pairs of bird wings. These wings represent families coming together. She placed the basic pattern in the Cartesian plane to successfully demonstrate translation and rotation as shown in Figure 1 and later built upon this design to create a colour animation. One frame of the animation is shown in Figure 2(c).

Many of my South Auckland students have a Pasifika background. Recently, the New Zealand Police have acknowledged the importance of these patterns to New Zealanders of Pasifika origin by placing traditional designs on new police cars. See Figures 2(a) and 2(b). Traditional mathematical art may be used in many ways to connect communities.

Insights and Observations

This assignment allowed the introduction of mathematical terminology such as translation, rotation, scaling and glide reflection in a natural way. Many students overlaid their design on a grid and picked out the relevant transformations.

The presentations have been very successful at the beginning of semester, creating immediate and lasting introductions. There is a huge sense of achievement felt after these presentations. Students are looking at their own cultural designs in a new way, proud to show what they had known or discovered. Some talked to their families and found out stories and history of which they had been unaware. 'A cool assignment' was one comment I heard. Some students gave a very animated delivery and others tended to be quietly proud. Some brought in fabric and cushions to pass around. This assignment introduces the students to an appreciation of the role mathematics plays in art and design, and helps to develop the skills of documentation, putting their art in context and general discussion. I remind the students that they can build on the work in this assignment when we code and make our own designs.

An online questionnaire on the value of teaching mathematics and coding to art and design students was made available to the 2019 students in the last few weeks of semester. It was not aimed at this assignment, but at the whole course. However, one text response is relevant to assignment one, namely 'I liked learning more about my culture in the presentation assignment'. This comment highlights that, for at least one student, the emphasis was on culture, rather than mathematics. The geometric content appeared to be absorbed as a result of the cultural research. Hence this assignment may be a way of introducing mathematics by stealth, almost without it being noticed.

This assignment could be given in many contexts, for example, in history, art, design, mathematics, engineering and architecture lectures. In my class it was very successful, delivering value in many ways, growing confidence socially, in art, design, mathematics and in cultural appreciation.

Acknowledgements

References

[1] Processing webpage. https://processing.org.