

# Math 32, ‘The Shape of Space’

Peter Doyle

Winter 2010

Welcome to ‘The Shape of Space’!

In this course we will cover a broad range of topics in ‘geometry’, which we take to include such fields as topology and differential geometry as well as more classical geometry. The aim will be to convey the richness, diversity, connectedness, depth and pleasure of mathematics.

This course is a descendant of a course called ‘Geometry and the Imagination’, developed about 20 years ago at Princeton by Bill Thurston, Peter Doyle, John Conway, and Jane Gilman. That title was cribbed from the English translation of the famous book ‘Anschauliche Geometrie’ by Hilbert and Cohn-Vossen, which literally means something more like ‘visual geometry’. Math 32 at Dartmouth is called ‘The Shape of Space’ in honor of Jeff Weeks, Dartmouth ’78, who wrote our course textbook. While ‘imagination’ may not figure in the title, it is a main emphasis of our course (and Jeff’s book!). *Imagination*, an essential part of mathematics, means not only the facility which is imaginative, but also the facility which calls to mind and manipulates mental images. One aim of the course is to develop the imagination.

While the mathematical content of the course will be high, we will try to make it as independent of prior background as possible. Abstract algebra, for example, is not a prerequisite. While you won’t need a heavy formal background for the course, you do need a commitment of time and energy.

## **Philosophy**

In this course, we will emphasize the *process* of thinking about mathematics. Assignments will involve thinking and writing, not just grinding through formulas. There will be a strong emphasis on projects and discussions rather than lectures. All students are expected to get involved in discussions, within class and without.

The spirit of mathematics is not captured by spending 3 hours solving 20 look-alike homework problems. Mathematics is thinking, comparing, analyzing, inventing, and understanding. The main point is not quantity or speed—the main point is quality of thought. The goal is to reach a more complete and a better understanding. We will use materials such as Tinkertoys, Legos, mirrors, scissors and tissue paper not because we think this is easier than solving algebraic equations and differential equations, but because we think that this is the way to bring thinking and reasoning to the course.

### **Staff**

- Instructor: Peter Doyle, 331 Kemeny Hall, 603-646-1058. Office hours: Right after class MWF; Thursday 12:00-1:50 in 120 Kemeny; by appointment.
- Graduate student assistant: Patricia Cahn, 243 Kemeny Hall, 603-646-9818
- Undergraduate assistant: Taylor Campbell.

### **Class meetings**

The class meets in the 12 slot, MWF 12:30-1:35 in 105 Kemeny Hall.

We will be holding help sessions during the x-hours, Tu 1:00-1:50. At times we will also hold class during the x-hours, so keep this time open.

When you will not able to attend class, I would appreciate it if you would send me email in advance.

### **Course materials and textbook**

The main resources for the course will be the handouts for ‘Geometry and the Imagination’ on my webpage, and the text ‘The Shape of Space, Second Edition’, by Jeffrey R. Weeks.

### **Grading**

Your grade will be based on written assignments, class participation, occasional quizzes, and a major final project.

## Projects

Final projects will be presented at a ‘Geometry Fair’, held at the end of the quarter, just before the start of the reading period for final exams. Your final project may be on any topic related to geometry or topology. It should be something you are really interested in, because a good final project will require a minimum of 17 Keplers of effort per person. You are encouraged to work together in groups of two or (at most) three, bearing in mind that a three-person project should aim to display 51 Keplers of apparent effort. The focus of the project should be on learning, with the presentation a way of showing what you have put into it and got out of it.

In conjunction with the final project, we will be expecting a written report. This written report is NOT the focus of the project. This report should include acknowledgement of sources you have consulted. In particular, you will need to list in detail the source of any copyrighted material you use in your project presentation or written report. Any such use must at a minimum be legally permissible under the doctrine of fair use. Beyond that, you should understand that incorporating images or text from the web makes a terrible impression, even in cases where it may be legally permissible and you have included complete citations.

## Challenge

Students come to this course from a wide variety of backgrounds. As a consequence, some students have no trouble with assignments that other students find very challenging. This is perfectly natural. The course is set up with the aim of allowing sufficiently motivated students to do well no matter what their background. My point here is to encourage better prepared students to push themselves beyond what is required to complete the formal assignments. The final project is one place to push yourself, but you can also do this by going beyond what is needed to complete the written assignment. If you found the assignment easy, take it to the next level. So for example, if you had no problem getting from the figure-8 knot to its mirror image, do it with a bike chain. Will this extra effort be reflected in your grade? Probably, at least under the heading of ‘class participation’. But, I’m hoping that you will do this for its own sake. I realize that there is an inherent contradiction in asking you to do something for its own sake. That’s not really what I have in mind. I just want to let you know that the formal assignments are not supposed to represent any kind of limit on what I’m hoping you will be getting out of the course. I dare say that all your

professors at Dartmouth feel this way, and I guess I'm just emphasizing it here because this course is a little different from other courses.

### **Honor Code**

Students are encouraged to work together to do homework problems. What is important is a student's eventual understanding of homework problems, and not how that is achieved. The honor principle applies to homework in the following way. What a student turns in as a written homework solution is to be his or her own understanding of how to do the problem. Students must state what sources they have consulted, with whom they have collaborated, and from whom they have received help. Students are discouraged from using solutions to problems that may be posted on the web, and as just stated, must reference them if they use them. The solutions you submit must be written by you alone. Any copying (electronic or otherwise) of another person's solutions, in whole or in part, is a violation of the Honor Code.

If you have any questions as to whether some action would be acceptable under the Academic Honor Code, please speak to me, and I will be glad to help clarify things. It is always easier to ask beforehand than to have trouble later!

### **Disabilities**

I encourage any students with disabilities, including "invisible" disabilities such as chronic diseases and learning disabilities, to discuss appropriate accommodations with me, which might help you with this class, either after class or during office hours. Dartmouth College has an active program to help students with disabilities, and I am happy to do whatever I can to help out, as appropriate.

The Student Disabilities Coordinator, Nancy Pompian, can be reached at 6-2014 if you have any questions. Any student with a documented disability requiring academic adjustments or accommodations is requested to speak with me by the end of the second week of the term. All discussions will remain confidential, although the Academic Skills Center may be consulted to verify the documentation of the disability and advise on an appropriate response to the need. It is important, however, that you talk to me soon, so that I can make whatever arrangements might be needed in a timely fashion.

## Sources

- The general introduction and ‘philosophy’ section are adapted from materials from ‘Geometry and the Imagination.
- The sections on ‘honor code’ and ‘disabilities’ are copied from Pete Winkler’s syllabus for Math 100, Winter 2010.