

# COGS 152: Cognitive Foundations of Mathematics

Spring 2015; T Th, 12:30-1:50pm; Mandeville B-104

\*\*\* subject to change \*\*\*

## 1 Personnel

### Instructor

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Office hours: Th 2-3, SSRB 203

## 2 Official Course Description

“How the human mind/brain creates mathematics: embodiment, innovation, and creativity. The emergence and power of abstract concepts, such as infinity, infinitesimals, imaginary numbers, or zero. Cognitive approaches that connect mathematics to human thought in general.”

## 3 Course Description

This course is an introduction to the cognitive science of human abstraction, focusing on a paradigmatic case study: *mathematics*. At first glance, mathematics appears unique for its objectivity, certainty, and abstraction. And yet it must rely on the same cognitive, biological, and cultural resources as any other human activity: brains, bodies, practices, artifacts. This poses a variety of puzzles. Are there “number” neurons in the brain? How is mathematics different from religion? How can we understand and reproduce Euclid’s proofs, despite the passage of thousands of years? If mathematics is a cognitive accomplishment, does that mean it’s subjective and culturally-relative? What is the role of gender, race, or emotion? Our approach throughout will be resolutely naturalistic—grounded in the latest research in cognitive science (broadly understood)—and will treat mathematics as both a system of knowledge and a human practice.

## 4 Learning Objectives and Outcomes

I have three main learning objectives for this course.

The first is for you to understand the **latest empirical research on mathematical cognition**, from simple numerical abilities in infants to abstract proofs by experts. To this end, we will read and discuss primary literature from neuroscience, psychology, philosophy, linguistics, and anthropology. By the end of this course, you should be able to cite a range of empirical results from the cognitive science of mathematics and feel comfortable reading new research in the field.

The second objective is for you to **acquire tools for thinking** about how mathematical practice could possibly **produce and reproduce facts that appear timeless, abstract, and certain**. You will take a small step toward accomplishing this in a capstone case study.

The third objective is to **use mathematics as an illustrative case study of human abstraction** more generally. By the end of the course, you should be able to discuss the similarities and differences between mathematics and other conceptual domains and cultural practices, from politics and physics to religion and poetry.

## 5 Prerequisites

Cognitive Science 1, or Philosophy 1, or Psychology 1, or Education Studies (20 or 30 or 31); upper-division standing. Otherwise, seek permission from the instructor.

## 6 Requirements and Evaluation

This course requires regular in-class participation, one response paper per week, an annotated bibliography, two midterms, and a final exam.

### 6.1 Breakdown of Final Grade

• Engagement and Participation	10%
• Reading Response Papers (10 x 1 page)	15%
• Case Study (groups of 2 or 3)	10%
• Midterm exams	35%
• Final exam	30%
• Bonus: Experiment Participation	+3%

Additional details on assignments and exams will be provided in class.

### 6.2 Engagement and Participation (10%)

*Objective:* Critical reflection is crucial to understanding and mastery. To encourage genuine engagement, nearly a sixth of your grade will come from:

- participation in peer-discussion during lecture (8% of final grade)
- reading quizzes, designed to encourage timely reading (2% of final grade)

Here's the deal: I want you to put in the effort to read, reflect, and participate during lecture. In return, you can earn these easy points toward your final grade.

*Discussion Questions:* We will be using Peer Instruction, a pedagogical technique in which students periodically break into small groups for discussion. Discussion prompts will assume that you have read and reflected on the day's required reading, so all readings *must* be completed before lecture. These discussions with your peers will be challenging and fun. (I hope!) The prompts are designed to encourage deep,

critical engagement with the course material, *not to test your knowledge or to “catch” students who have not done the reading.*

We will use the iClicker system to record the outcomes of these discussions, so you must buy an iClicker (available, new and used, at the campus bookstore). You must click in at least 80% of the time during the quarter to receive full “clicker” points (thus allowing for funerals, births, illness, etc.). If you click in less than 80% of the time, you will only receive partial marks. You will not be graded on whether you indicate the “correct” answer—only for participating.

*Quizzes:* In order for peer discussions to be fruitful, you need to complete the day’s required reading *before* lecture. I appreciate that it is difficult to keep up with the reading. To reward your effort, some lectures will start with a brief, simple quiz. The answers will be obvious if you did the reading. I’ll drop your worst quiz grade.

### **6.3 Reading Response Papers (15%)**

*Objective:* Practice *critical* and *constructive* engagement.

*Instructions:* Pick one of the reading’s claims. Spend 2-3 sentences summarizing this claim. **The rest of your response should evaluate and respond, critically but generously.** Take risks! Disagree! But make sure to defend your criticism. These aren’t opinion papers but an opportunity for you to practice scholarly engagement.

*Format:* Between  $\frac{3}{4}$  (min) and 1 page (max), single-spaced, 12pt, Times New Roman. At the top, indicate the paper’s author[s] and title and your PID (no name).

*Grading:* “check” (good), “check plus” (exceptional insight), or “check minus” (unacceptable: too short, too long, too superficial, etc.). Most papers will receive a “check” and 1.5 points. You may receive at most one “check minus” and still receive full points for that response; future “check minuses” will receive only one point (or even .5 pts). Each “check plus” is worth two points, up to the maximum of 15 points.

*Due date:* At the start of class for which the reading is assigned, in hard copy. No response papers will be accepted after the start of lecture. You may submit only one response paper per week; said otherwise, you should submit a response paper *weekly* in order to receive full marks.

### **6.4 Case Study (10%) (groups of 2 or 3)**

*Objective:* Learn to synthesize and apply the broad range of results and theories introduced in the course, and practice a multidisciplinary, cognitive-scientific analysis of human abstraction.

*Instructions:* Conduct a case study of one mathematical concept, technique, activity, or phenomenon. The case study should highlight a clear, tractable puzzle. Examples include: How do we figure out the tip in a restaurant? Why do mathematicians agree

about the postulates of Euclidean geometry? Does speaking more than one language make it easier or harder to acquire basic number concepts? Each case study will review a *minimum* of six papers per group member, including four from outside the course (i.e. on neither the syllabus nor the lecture slides).

*Format:* The case study will consist of a series of critical review of the literature (i.e., an “annotated bibliography”) and a short summary of your findings. Usual boring formal demands: double-spaced, 12pt, Times New Roman, standard margins.

*Due dates:* By the end of Week 6, you’ll select the target of your case study in consultation with the professor. In Week 10, you’ll give and receive feedback on a rough draft of the case study. The case study is due on Monday of Exams Week. More details to follow.

### **6.5 Exams (17.5% for each midterm; 30% for the final)**

Exams cover material from both lectures and readings. For the assigned readings and lectures, you should be able to articulate: the general topic, the hypotheses or research questions, the methodology (or methodologies) employed, the main claims or results, and a critical assessment of any of these parts. Format is multiple-choice, with multiple correct answers (to be discussed in class). Final exam is cumulative.

### **6.6 Experiment Participation**

You can earn bonus points by participating in psychology experiments, using the SONA system (<http://ucsd.sona-systems.com>). Each hour of SONA participation is worth one percentage point, up to a maximum of three. In place of SONA participation, you can attend an academic talk related to Cognitive Science and write a one-page summary of the talk. Also include the talk’s abstract and a link to the talk’s announcement. Any talk listed on the Cognitive Science Department’s website calendar is acceptable; if a talk isn’t listed, check with the professor or TA.

### **6.7 Grading Rubric**

Course grades will be assigned according to the following scale:

- ≥ 97%: A+
- ≥ 93%: A
- ≥ 90%: A-
- ≥ 87%: B+, etc.

If this produces a distribution of grades with a median lower than 80%, a curve will be applied to bring grades up.

## 7 Course Policies

### 7.1 Electronic Devices

In order to maintain an engaging learning environment, all electronic devices must be turned off or silenced before the start of class. ***This includes tablets, laptop computers, and cellphones.*** If you have an outstanding reason for using your tablet or laptop (e.g. you prefer digital notes), then please discuss this with me before class. You should then sit in the front row. The only time when it is appropriate for anybody (and everybody) to open their laptop is if a classroom discussion hinges on a detail from one of the readings.

You may have a pressing reason for checking text messages or accepting phone calls during class (e.g. you or your partner is pregnant and the due date is approaching; you have children at home for whom you are responsible; a loved one is sick and you need to respond quickly to changes in their health). Please let me know at the start of class and, if necessary, step outside the classroom to use your cell.

### 7.2 Email

*This policy is adapted with permission, sometimes verbatim, from Prof. Spring Duvall.*

Please use email to share fun course-related content (e.g. articles that touch on course themes, relevant quotes from literature, etc.) or to set up a face-to-face meeting. For more in-depth discussions (such as guidance on assignments) please plan to meet in person, either in my office hours or before or after lecture.

If you have questions about course mechanics, please do the following, in order: check the syllabus, ask other students in the course, ask your question during lecture, try to attend office hours, and only then send me an email.

If you cannot attend my office hours, please email me to set up an individual face-to-face meeting! I love chatting with students. I really do. Your message should include at least two timeslots when you would like to meet and a brief (1-2 sentences) description of the reason for the meeting. I am also available by Skype or by phone during office hours, in case you are able to talk but unable to come to campus.

**In general, our conversations should take place in person or over the phone rather than via email, thus allowing us to get to know each other better and fostering a more productive, interactive learning atmosphere.**

### 7.3 Accommodations for Disabilities

Students requesting accommodations for this course due to a disability must provide a current Authorization for Accommodation (AFA) letter issued by the Office for Students with Disabilities (OSD), which is located in University Center 202 behind Center Hall. Students are required to present their AFA letters to Faculty

(please make arrangements to contact me privately) and to the OSD Liaison in the department in advance so that accommodations may be arranged. Contact the OSD for further information: 858.534.4382, osd@ucsd.edu, disabilities.ucsd.edu

#### **7.4 Academic Misconduct**

I check assignments for plagiarism and report all suspected cases of academic misconduct to the Academic Integrity Office. **I really do.**

Here's a brief blurb from the Academic Integrity Office: "Integrity of scholarship is essential for an academic community. The University expects that both faculty and students will honor this principle and in so doing protect the validity of University intellectual work. For students, this means that all academic work will be done by the individual to whom it is assigned, without unauthorized aid of any kind."

In this class, you are encouraged to discuss assignments and readings with your peers. All assignments, however, must be written by you, must contain your own ideas and words, and must clearly indicate where the ideas or words of others have been incorporated into your assignment (e.g. include an appropriate citation). **This applies to *all* submitted work, including rough drafts.**

The general sentiment is this: We want you to acquire new knowledge and new skills. We also need to evaluate your mastery of that knowledge and those skills. Both these objectives demand that you do your own thinking and writing. If you're ever unsure about whether something qualifies as academic misconduct, *please ask!* Asking if something counts as "cheating" is *encouraged*. We are very happy to have a friendly discussion about what counts as academic dishonesty.