Using Mathematics to Understand Our World
Course Syllabus
Spring 2009

1 Instructional Staff

Susan Cooper (instructor)

Bio: Susan is the *Marilyn M. Hitz Assistant Professor* in the Department of Mathematics at UNL. Her research interests are in Commutative Algebra & Algebraic Geometry. Susan is a "pure mathematician". This is her first year at UNL and she is very much enjoying the Nebraska spirit. Susan grew up in Regina, Saskatchewan, Canada. After initially majoring in performance theatre, Susan changed her undergraduate major to mathematics in which she obtained a Ph. D. from Queen's University. In her free time, Susan enjoys dancing, theatre, baking, and playing with her two (very naughty!) cats Sophie & CJ.

Contact Information: Susan's office phone number is 402-472-7253. Her email address is `scooper4@math.unl.edu`.

Michelle Homp (instructor)

Bio: Michelle is employed half-time by the *Center for Science, Mathematics and Computer Education* to work on the *Math in the Middle* project. She also works with joint efforts between UNL and Lincoln Public Schools to offer professional development classes for LPS teachers. Formerly, she served on the faculty at Concordia University in Seward, NE (which is where she lives). Michelle's husband, Gerald, also works in Lincoln and they have three children: Nolan (9), Levi (7) and Callie (4).

Contact Information: Michelle can be reached by phone: 402-472-7259 TR or 402-643-4423 MWF. Her email address is `mhomp@lps.org`.

Chris Ahrendt (graduate student assistant)

Bio: Chris is in his fourth year of graduate school at UNL. He is studying dynamic systems on time scales and anticipates graduating in May of 2010. Chris grew up in South Dakota, and attended Dakota State University as an undergraduate where he majored in Mathematics and Computer Science. Chris and his wife, Carol, have been married for two and a half years.

Contact Information: Chris can be reached by phone at 402-472-8038. His email address is `s-cahrend1@math.unl.edu`.

Deanna Dreher (graduate student assistant)

Bio: Deanna is in her fifth year of graduate school at UNL. She is working in Coding Theory and is planning on graduating in May of 2010. Deanna grew up bouncing around Germany with her military family, before attending college in Colorado. There she met her future husband, Josh, though they weren't married until 2007. She and Josh are expecting their first child in August.

Contact Information: Deanna's university phone number is 402-472-8038. Her email address is `s-dturk1@math.unl.edu`.

Silvia Saccon (workshop assistant)

Bio: Silvia is a fifth year graduate student in the Mathematics Ph.D. program at UNL, and she is working in commutative algebra. Silvia is originally from Venice, Italy. A graduate from University of Padova (Italy), she decided to continue her studies in the United States and came to UNL in 2004.

Silvia will be working with us only during the January Workshop.

2 Acknowledgements

Math 807T - Using Math to Understand Our World was developed by Wendy Hines. Wendy has been on the faculty at UNL for 15 years. Her research area is Differential Equations with applications to Biology. Wendy does both theoretical and applied work. She grew up in a small town in northern Illinois (now it's a suburb of Chicago, but then it was pretty rural). Wendy is married to Jamie Radcliffe, an Englishman, who is also in the math department, and they have one daughter Elly.

The materials for this course were written by Wendy. Most of the personal references are experiences that Wendy wished to share with the *Math in the Middle* students. Some references have been enhanced to reflect the experiences of the current intructional staff.

3 Course Goals

Teachers will gain an appreciation of the many complex and important ways in which mathematics is used in modern society. Teachers can see how many real-world problems can be put into mathematical language and how mathematical language gives us a way to analyze such problems and predict future outcomes. Teachers will experience this process first-hand as they use mathematics to analyze several real-world problems. Teachers will become better at identifying the mathematics in real world problems and at translating these problems into mathematics. Teachers will see how good mathematical habits of mind have allowed people to build a better understanding of the world and how this understanding has been used to make the world a better place. Teachers will build mathematical communication skills by communicating what they learn to instructors, colleagues, and students.

4 How the Course Works

The course will begin with an intensive two-day workshop January 23rd and 24th at UNL. In the January Workshop, we will discuss many tools for translating real-world problems into mathematics, especially functions. While we will review linear and polynomial functions, we will focus mainly on exponential functions. We will practice using functions to describe practical situations. There will be some homework problems assigned during the workshop which you will do Friday evening. A first draft of these homework problems will be due Saturday morning. Some of the problems will be commented on by an instructor-grader and the entire homework will be handed back to you sometime Saturday. A final draft will be due the same day as Project 1 (see below).

The rest of the course will be entirely project based. There will be 6 projects during the semester (they are all described below). Projects will be mailed to you throughout the semester and write-ups must be mailed back, post-marked no later than the project due date. If technology allows, you can email your project write-ups to me, but otherwise snail mail them to:

Center for Science, Mathematics and Computer Education
251 Avery Hall
University of Nebraska
Lincoln, NE 68588-0131

Projects will be graded and sent back to you in a timely manner. Expect copious comments.

During the semester, you will also be required to do a *Teaching and Learning Project*, discussed below. In addition, you will also be asked to write a one-page *Reflection* (which you can do any time in the last half of the semester). At the end of the semester, there will be an *End-of-Class Assignment*, also discussed below.

4.1 How Projects Work

Every few weeks, a new project will be mailed to you in a plain brown envelope. Inside the envelope you will find:

1. A "Project Description"
2. Readings
3. Reading Guides
4. Interesting documents for your reading pleasure (which are not required unless otherwise indicated)
5. A "What to Hand In" sheet

Every project will have a "Project Description" and a "What to Hand In" sheet. Throughout each "Project Description", many questions will be interspersed. Some of these will be

rhetorical and some will be part of what you need to hand in. Questions in the "Project Description" that will also appear on the "What to Hand In" sheet will always be in boldface. I try to always include space in the "Project Description" for you to answer the questions right where they appear in the project text. Then when you get to the "What to Hand In" sheet, you will have easy access to these answers. The only thing you ever need to hand in is what's listed in the "What to Hand In" sheet (which may include a few questions **not** in the "Project Description"). Sometimes this will be answers to a list of questions and sometimes it will be more of an essay-style report on the work you did in the project. Either way, what you need to hand in will be described fully in the "What to Hand In" sheet.

My advice is to first work through the project, answering all questions, and then complete the "What to Hand In" sheet and hand it in. **The projects are designed to be discussed in groups. You will have a hard time working alone in this class.** Though I expect projects to be hammered out in groups, each individual should hand in their own final write-up. If two people hand in identical projects it will cause great consternation amongst the instructors.

Here is a list of the projects we will do.

Project 1: *Measuring Temperature & Newtons Law of Cooling*

We will begin this project with a discussion of how temperature is measured. We will make our own thermometers, devise our own temperature scale and use these things to measure the temperatures of various samples, and we will convert from one person's scale to another. Then we will use exponential functions to describe the temperature of objects which are cooling or heating and use these functions to predict future temperatures of these objects.

Project 2: *Using Body Temperature to Measure Time Since Death*

We will build on Project 1 to learn how to use the temperature of a dead body to determine an approximate time of death. There is a whole science to this and we will learn some of the history and some of the different algorithms. Then we will use what we have learned to solve our own murder mystery!

Project 3: *Containing Infectious Diseases*

We will learn how to mathematically model the spread of an infectious disease and we will use our work to form strategies for containing disease outbreaks (that is, keeping outbreaks from becoming epidemics). We will study government reports about strategies for responding to a possible smallpox terrorist attack. We will learn about how good mathematical habits of mind were used to determine the cause of cholera and thus save millions of lives.

Project 4: *Can You Save Tom's Marriage?*

Tom wants to maximize the amount of time his VCR records a movie in high quality mode (versus low quality mode). In high quality mode, he can only record a two hour movie on one tape, but most movies are longer than that, so he tries to program his VCR to

record first in high quality mode and then, at some point, switch to low quality mode. But he always messes up and, as a result, the tape finishes before the movie does. His wife is very frustrated with him! We will use linear functions to help Tom figure this out. The mathematics here applies to any sort of recording device that has more than one quality mode, for example a digital video recorder.

Project 5: *Building Up Savings and Debt*

In this project, we will build on what we learned about compound interest during the January Workshop. We will learn how to compute the value of an annuity when we make regular deposits into the annuity. We'll see how surprisingly quickly an annuity can grow and we'll see the advantages (mathematically) in starting an annuity early. We will also apply these ideas to credit card debt to see how debt grows astronomically if part of the principal is carried over from month to month. And we will apply this mathematics to the national debt!

Project 6: *Making and Using Childhood Growth Charts*

We will learn how childhood growth charts are made and used, and we will use them to predict when children are at risk of developing adulthood obesity or failure-to-thrive.

4.2 Groups and Class Communication

You will be divided up into discussion groups of 5 or 6 people, with an instructor assigned to each group. Your group instructor will be the person you go to for help, questions, etc. Each group will have their own discussion board on Blackboard. Beyond that, it is up to each group to decide how to communicate. You can use email, teleconferencing, in-person meetings ... whatever works well for your group and your group instructor.

There will be some instances where you will be requested to post ideas to your group's discussion board on Blackboard. You must contribute to such discussions at least once (per discussion).

4.3 Teaching and Learning Project

Because this will be a very busy semester for you with your *Research Action Project* and this class at the same time, we will do a very pared-down *Teaching and Learning Project*. I would like you to find something in the class that you enjoyed and found interesting and tell your class about it. Write one page about what you shared with your class and how it was received. More details and expectations for this project are included in your course binder.

4.4 Reflection

I ask that you submit a one-page *Reflection* on what you have learned during the class. This can be done any time during the last half of the semester. What have you learned? Were there some things that you found particularly interesting? surprising? meaningful? Has your perception of mathematics changed any? If so, in what ways? Has what you learned

had any effect on your teaching? If so, how? Anything else you would like to say about your experience in the course?

4.5 End-of-Course Assignment

For the *End-of-Course Assignment*, you will be asked to rewrite, carefully, one of the projects (you choose which one) you have done during the semester, taking into account the grader's comments and other things you may have learned since you first did the project. You should elaborate on the work you did in the project, providing interesting material from other sources such as the internet, newspapers, magazines, etc. Full credit will only be given to those people who add a little extra to their end-of-course project, besides just answering all the questions correctly. You should also attach a sheet to your *End-of-Course Assignment* describing what changes you have made and what you have added to your original project. Though the *End-of-Course Assignment* will be officially assigned May 11 and due May 25, you may start on it and turn it in at any time. You are not allowed to use Project 4 for your *End-of-Course Assignment*.

5 Assignment Dates and Grades

The following table shows when each project will be assigned, when it is due and how many points it is worth.

Assignment	Assigned Date	Due Date	Points
Workshop Homework	Friday Jan. 23	Wednesday Feb. 11	50
Teaching & Learning	Friday Jan. 23	Monday May 18	10
Project 1	Saturday Jan. 24	Wednesday Feb. 11	50
Project 2	Monday Feb. 9	Monday Mar. 2	50
Project 3	Friday Feb. 27	Monday Mar. 23	50
Project 4	Friday Mar. 20	Monday Apr. 6	30
Reflection	Friday Mar. 20	Monday May 25	10
Project 5	Friday Apr. 3	Monday Apr. 27	50
Project 6	Friday Apr. 24	Monday May 18	30
End-of-Course	Monday May 11	Monday May 25	30
Total			360

6 Course Grading

Part of our responsibility as the instructional staff is the assessment of participants' achievement in each *Math in the Middle* course. We recognize that teacher-participants are drawn from different grade levels, have different certifications to teach mathematics, have varying kinds of teaching experiences, and have different educational backgrounds with respect to previous opportunities to learn mathematics and learn about inquiry into teaching. Thus, we believe it is appropriate to have an assessment system that values effort; teamwork; progress in learning mathematics; and in the development of knowledge, skills, and dispositions for teaching and inquiry.

Grade	Expectations and typical characteristics of achievement at that level
A+	The grade of A+ is honorific and will be fairly rare. It is evidence that the instructors have special admiration for the participant's achievements in the course.
A	Achievement beyond the level needed to earn the grade of A-. Especially important will be evidence that the teacher has a good command of the mathematics studied in the course; the ability to transfer mathematics learned into the teacher's classroom; and progress in developing the knowledge, skills and dispositions of educational inquiry.
A-	Achievement beyond the level needed to earn a grade of B+. In particular, there should be clear evidence of significant progress in learning mathematics; in learning about issues that impact teachers' ability to help their students learn mathematics; and developing knowledge, skills, and dispositions of educational inquiry.
B+	Regular class attendance, active participation, assignments submitted regularly, supportive and helpful to peers, admirable effort to complete assignments, evidence of good progress in learning mathematics and in developing knowledge, skills, and dispositions of educational inquiry.
B	Regular class attendance, reasonable participation, cooperative with peers, reasonable effort to complete assignments, to learn mathematics, and to strengthen knowledge, skills, and dispositions of educational inquiry.
B-	A grade of B- (or lower) is a statement that the instructors do not believe that the teacher made a reasonable effort to use the opportunity provided by the *Math in the Middle Institute* to develop into a stronger teacher. Evidence may include one or more of the following traits: attendance problems, uncooperative behavior, failure to submit assignments, habitual tendency to submit assignments late, or performance on assignments that indicate an inadequate effort to learn mathematics and to develop knowledge, skills, and dispositions of educational inquiry.