Theories about gain scores & Posttest scores:

At Student level:

1. Student's prior knowledge, measured by CACT will negatively impact gain score. That is, students who know more will have less to learn and will experience a ceiling effect. This may be a non-linear interaction: below a certain level of CACT, the gain may be negatively affected because the student doesn't know enough to learn anything.

2. However, student's prior knowledge as measured by the pre-test will positively impact post-test score. Probably the Cact won't make much difference after controlling for the pre-test.

3. Student's self-assessment wil correlate with gain score: If they think they are good at math, they will learn more. If they like math they will learn more. (These two are in the same attitude measure.) If they think math is useful they will learn more. (This one is in a separate measure, I think.)

4. Other things to think about:
- Prior math classes (high school)
- # college math classes
- Math major, minor or specialization
- Mother's education level (SES Proxy)
- Year in college

At instructor level (what do we do about section level?):
1. Textbook. How can we make this into a useful/usable variable? maybe we could categorize the textbooks. The idea behind the conjecture that the textbook will make a difference in gain is that textbooks that are easier for students and/or instructor to use will result in a more coherent and mathematically correct course. We should use Billstein as the reference, since it is the most widely used.

2. Class size. Usually we expect smaller classes to be correlated with more learning. In this case, we may see a high correlation between class size and institutional quality, with lower quality institutions having smaller classes.

3. Institutional quality: if we use average SAT/ACT from the public data, it will probably correlate with the average CACT score for students in each section. We should look at that. If the correlation is high, we could use the mean CACT at the second level, since it is really a level 2 (not a level 3) variable. This will probably be a good predictor of posttest, but not necessarily of gain. As with student CACT, we may have a nonlinear relationship, with lower gain at the low and high ends of the CACT spectrum.

4. Instructor rank: Maybe we should split it into tenured v. other; or tenured, tenure track, other.
The idea here is that instructor rank indicates something about both instructor mathematical knowledge, and instructor knowledge of teaching. On the one hand, the

tenured/tenure track instructors are likely to be mathematics professors with a background in research mathematics and thus, undeniable mathematical knowledge. On the other hand, the non-tenure track people are likely to be instructors who have experience teaching or who are hired because of their expertise in K-8 mathematics. It is not clear which group we would expect to achieve higher gains.

5. Instructor Experience (# times taught?)
The theory is that an experienced instructor may do a better job teaching this class than an inexperiences one, up to a point. This too may be a non-linear relationship with both new instructors and highly experienced instructors not doing as good a job as those in the middle.

6. OTL measures, not yet developed. But the theory is that once we have measures of OTL from the instructor survey that are directly related to the assessments, they will be important correlates of student learning.

7. Instructor teaching style/beliefs (not yet developed)
We would expect that instructors beliefs about teaching and learning could be important predictors of student gains. In particular, instructors who think math should be taught by lecture and practice may not be as successful. I say this because most of these students have had a LOT of experience with lecture and practice, and most of them have not been successful as mathematics students. So, doing the same thing over may not be the most effective strategy. This is an empirical question, though, and if we can discern from our data what kind of teacher each instructor is, this could be a very interesting hypothesis to test. We need to look again at the questions about attitudes and beliefs on the instructor survey.

8. Instructor attitude towards the class and towards the students: Do they think students can learn? Do they want to teach the class again?
This measure speaks to the instructor's motivation for teaching the class. By reputation, this is a class that "real mathematicians" don't want to teach and that many who teach it are resentful are not there by choice. If we could get a sense of this through our data, it would be very useful.

9. School characteristics: Things like public/private and size of school (though not really level 2 variables) could control for things not captured by school quality. Average tuition might be a good one, too.

Interactions

1. Instructor attitude will interact with student attitude. A mismatch here can be important as the instructor tries to teach in one way while the student likes to learn in another way.

2. Textbook will interact with student attitude. This will also be a question of match – the kind of book the student thinks is good depends on the student's ideas about mathematics learning. A mismatch will mean less learning, a match will mean more learning.

3. Class size might interact with pretest score: small classes may be more effective with students who are not as well prepared, larger classes with better prepared students. I'm not sure if I am thinking about this one right!

4. A similar interaction between instructor experience and pretest: more experienced instructors may do a better job with less prepared students.

4. There are other interactions that might occur with student variables:

Instructor rank with student major/minor (math majors responding better to math professors, worse to k-12 teachers)

Instructor attitude toward students (if we have a measure of it) with student SES/mother's education

School level:

We don't have enough data to estimate coefficients. Many schools have only one instructor and/or one section.