1.Objectives or purposes

The relationship between teachers' attitudes or dispositions and student performance is frustratingly difficult to determine, as evidenced by previous research studies (e.g., (Klassen, Tze, Betts, & Gordon, 2011) and informal reports by teachers and others, who confirm that changes in teachers' attitudes do not often result in student academic growth (Yoon, Duncan, & Lee, 2013). And yet maximizing academic growth is the primary goal of (a) teacher selection, (b) teacher education (both preservice and inservice), and (c) the development of policies influencing the work of teachers. The purpose of our study is to determine if certain teacher attitudes and dispositions are associated with student gain scores in mathematics.

Previous research has demonstrated a link between teacher knowledge of mathematics and student achievement (Hill, Rowan, & Ball, 2005). In addition, many studies report a relationship between teacher characteristics (e.g., experience, scores on licensure content tests, credentials) and mathematics achievement (e.g., (Clotfelter, Ladd, & Vigdor, 2007). Taken together, these findings suggest that teacher education (learning) and the selection of teacher characteristics are useful "levers" that, if properly influenced, can result in higher mathematics achievement for students. We argue that certain teacher attitudes and dispositions may also be associated with achievement in mathematics, and if these attitudes and dispositions are malleable, they can be augmented, and result in achievement gains.

Our data source is the High School Longitudinal Study (HSLS), a nationally representative database with a sample size of about 25,200 students. The first wave of the HSLS, released in 2009, represents the latest national data collection effort from the National Center on Education Statistics. We used the following multi-item teacher attitude scales to explore their relationship to gain scores in mathematics: (a) math teacher's perceptions of math professional learning community (b) math teacher's perceptions of collective responsibility, (c) teacher's perceptions of self-efficacy, (d) perceptions of school's math teachers' expectations, and (d) math teacher's perceptions of the principal's support. We also added several student level variables to our Ordinary Least Squares (OLS) models to account for the role of ethnicity, SES, and English

Learner status might play in mathematics gain scores and teachers' attitudes. By using gain or change scores as our dependent variable, we are both advancing a methodological position while exploring constructs we hypothesize to be associated with changes in mathematics scores.

2. Theoretical framework

Because we are exploring many constructs in our work but have limited space in the proposal, we will limit the theoretical framing to the relations among teacher self-efficacy, teacher expectations and mathematics gain scores. The full paper will include a discussion of all the scales used in our models.

Self-efficacy is a largely cognitive process in which individuals generate beliefs about how their persistence, response to potential failure, and coping strategies will affect their performance on a certain task or tasks (Bandura, 1993). Research on teacher efficacy has shown a link between teachers' beliefs about their own pedagogical skills and their actual performance, although the particular cause-and-effect relations remain equivocal (Washburn, 2006). Teacher's perceived self-efficacy has been found to be associated with several student dimensions, such as enhanced motivation, increased self-esteem, increased self-direction, and more positive attitudes toward school. An earlier study found a relationship between teacher collective efficacy and positive views of the school's English instructional program (Téllez & Manthey, 2015).

However, we believe that too few studies have investigated the relation between teacher self-efficacy, teacher expectations, and student achievement, especially those in which achievement is measured by the types of tests that policymakers tend to rely upon (i.e., multiple domains assessed in a norm-referenced format). The HSLS offers the opportunity to explore these measures and their relation to achievement.

One of the few studies exploring the relationship between teacher self-efficacy and student academic performance, (Caprara, Barbaranelli, Steca, & Malone, 2006) suggests a causal link from high student performance to teacher self-efficacy. This is a compelling finding, but if teacher self-efficacy is contingent upon high student scores then will teachers in disadvantaged schools ever believe they are efficacious?

Another study explored teacher *collective* efficacy (Moolenaar, Sleegers, & Daly, 2012), which is defined as teachers' judgment of their capacities to organize and execute the courses of action required to have a positive effect on student learning (Goddard, Hoy, and Hoy (2004). This study found that teachers' collective efficacy beliefs appeared beneficial to students' language achievement, but not for mathematics achievement. We suggest that collective efficacy is a concept measure two of the scales we are using in this study (teacher self-efficacy and collective responsibility).

Teacher expectations research began with great promise, especially on the belief that if teachers could come to expect more of disadvantaged students, their academic achievement would grow (Rosenthal & Jacobson, 1968). The intervening decades has tempered the enthusiasm for alternating teacher attitudes regarding expectations (Jussim & Harber, 2005), but the promise remains, and thus the topic is worthy of efforts to understand more fully the effects.

3. Methods

Gain scores of academic achievement are becoming a more common metric for teacher and school success. While we lack space here to draw readers through the history of the controversy, we recognize the decades of argument against the use of gain scores in educational research, mostly coming from psychometricians who argue that the multiplicative nature of score error, resulting from subtracting one score from another, cannot be ignored. For our part, we believe that the research literature has adequately addressed the concern (Williams & Zimmerman, 1996). However, even if one remains dubious of the use of gain scores, the educational policy world is accepting gain scores as a valid measure of school performance. Indeed, California's new accountability plan under new ESSA guidelines incorporates both a school's mean score relative to a minimum standard as well as assessing growth over years (http://www6.cde.ca.gov/californiamodel/).

Our methods involve a set of OLS models designed to assess the influence of teacher attitudes on mathematics gain scores.

4. Data sources

We employed the restricted data set from the High School Longitudinal Study (HSLS), ~~is~~ a nationally representative database with a sample size of about 25,000 students. HSLS researchers began collecting data on 9th grade students in 2009, and data set contains detailed hundreds of variables, including those of interest to us: mathematics achievement at both the 9th and 11th grade and a set of composite surveys of the students' math teachers (Ingels & Dalton, 2013). The HSLS questionnaires were electronically administered; in the base year, initial student respondents completed the questionnaires on a computer during in-school sessions, while subsequent follow-ups and parent questionnaires used web, computer-assisted telephone administrations, or in-person surveys.

The teacher attitude subscales (e.g., mathematics teacher's self-efficacy) were created through principal components factor analysis and standardized to a mean of 0 and standard deviation of 1. The self-efficacy scale, for instance, used seven input variables (e.g., "If you really try hard, you can get through to even the most difficult or unmotivated students") yielding in an alpha of .65. Our final dataset included approximately 9,000 cases.

5. Results

Table 1 share the means and standard deviations of variables used in the model.

Insert Table 1 here.

An OLS model was used to study the effects of individual variables on mathematics gain score. The overall model was significant ($F = 4.074$, $p > 0.001$; adjusted $R2 = 0.01$). Although we recognize that this model accounted for about one percent of the variability in gain scores, we remind readers that gain scores constrain variability in the outcome variable, and we are also measuring growth, which controls for a myriad of social and individual variables and assesses the influence of instruction for just two years. Our full analysis will include parallel models that will include 11th grade math scores as an outcome and 9th grade scores as covariate in order to confirm our gain-score models. We would further add that the teacher attitude variables were taken from the students' 9th grade teachers only. This is an important point. It means that the students' 9th grade teachers may have had a strong perception of self-efficacy, which may serve to increase a student's gain score. But because no data was collected from teachers from the students' teachers in the 10th or 11th grade, we can assume that these teachers held the typical variation of perceptions of self-efficacy. Therefore, the model is, in fact, including only the attitudes of 9th teachers and testing whether the effects of these teachers persists until the student is in the 11th grade, when the second assessment was administered.

Even under these conditions, we found several significant individual variables in the model. Table 2 shows the Beta weights, t values, and statistical significance for each predictor variable.

Insert Table 2 here

The most compelling findings, for our part, indicate that teachers' teacher's perceptions of collective responsibility and self-efficacy are both significant predictors of increases in mathematics scores. Interestingly, teachers' perceptions of professional learning communities and principal support were inversely related to gain scores. Finally, SES, gender, and ELL status were not significant in the model. Asian students, however, tended to show greater gains over the two years than other ethnic groups, when holding all other variables constant.

We note the full paper describes several other follow on models which deepen the analysis presented in this proposal.

6. Significance of the study.

Educational leaders and policymakers are keen to find those policy and pedagogical levers that will increase student achievement in mathematics. Our study suggests that teacher attitude variables are associated with mathematics gain scores. As with many correlational studies using large sample sizes, we recognize that our overall model—

although statistically significant—accounts for a very small proportion of the variance in score gains. Nevertheless, we suggest that we have identified several potentially useful policy implications. Our first conclusion is methodological and suggests that gain scores, when available, can be successfully employed in research on academic achievement. In our view, the historical psychometric concerns are not sufficient to disincline their use in all instances while recognizing the traditional critiques but suggest that the simple logic of gain scores offers a better chance to influence policymakers who are often perplexed by statistical models with dozens of covariates.

With regard to our specific findings, we have augmented the sparse literature demonstrating that teacher self-efficacy is associated with enhanced student achievement. Although our study's results are not overwhelming, we are confident that gain scores are associated with teacher self-efficacy. Second, teachers' collective responsibility for student learning, which we argue is akin to collective efficacy (Moolenaar et al., 2012) is also associated with gain scores. These finding corroborate other studies linking teacher efficacy and student achievement. More confusing, however, is the finding that teachers' perceptions of principal support are inversely associated with gain scores. It is understandable that principal support might have little or no influence on gain scores, especially at the high school level, but what could account for a statistically negative relationship in this regard? Finally, we found that Asian students were the only ethnic group who had significant gain scores, when holding all the other variables constant. We explore this finding in the full paper.

We have made the case that teacher attitudes and dispositions are more malleable than other characteristics of teachers, but this is frankly speculation on our part. For instance, a teacher's knowledge of content has been associated with higher student achievement, and we have demonstrated that certain teacher attitudes and beliefs are associated with increases in students' scores, but we cannot say that altering a teacher's sense of self-efficacy, for example, will be easier than augmenting content knowledge, although the two may be correlated. Similarly, developing a teacher's belief in their colleagues' collective responsibility, which we have shown to be a variable of interest in mathematics score gains, may be a non-trivial challenge. Nevertheless, if a school leader could be convinced that even small gains in mathematics scores result if the school's teachers develop a sense of collective responsibility, we suspect that most would consider the effort worthwhile.

Tables and References

Table 1: Means and standard deviations of variables used in the model.

Variable	Mean	SD
MScor_diff (DV)	-.0142	7.05941
Socio-economic status composite	.147960	.7930554
Scale of math teacher's perceptions of math professional learning community	.0330	.97374
Scale of math teacher's perceptions of collective responsibility	.0878	.99510
Scale of math teacher's self-efficacy	.0845	.93600
Scale of math teacher's perceptions of math teachers' expectations	.1192	.94334
Scale of math teacher's perceptions of principal support	.0257	.95718
Binary: Female	.5030	.50002
Binary: ELL Ever	.0525	.22302
Binary: Mexican	.1102	.31319
Binary: Asian	.1018	.30247

Table 2: Individual variable contributions to overall regression model

Variable	Beta	t	Sig.
(Constant)		-.787	.431
Socio-economic status composite	.023	1.886	.059
Scale of math teacher's perceptions of math professional learning community	-.027	-2.091	.037
Scale of math teacher's perceptions of collective responsibility	.040	2.828	.005
Scale of math teacher's self-efficacy	.030	2.576	.010
Scale of math teacher's perceptions of math teachers' expectations	.008	.574	.566
Scale of math teacher's perceptions of principal support	-.034	-2.735	.006
Female	-.013	-1.158	.247
ELL Ever	.015	1.310	.190
Mexican	.009	.710	.478
Asian	.025	2.125	.034

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